INSTRUMENT SHOP

INSTRUCTION BOOK

for

RADIO RECEIVING SET AN/URR-29

and

RADIO RECEIVER R-220/URR

MANUFACTURED BY

MOTOROLA INCORPORATED

ORDER NO. 116-PHILA-52-93

21 June 1954

Return to

Jim Downey

Systems

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WARNING

HIGH VOLTAGE

is used in the operation
of this equipment.

DEATH ON CONTACT

may result if operating personnel fail
to observe safety precautions.

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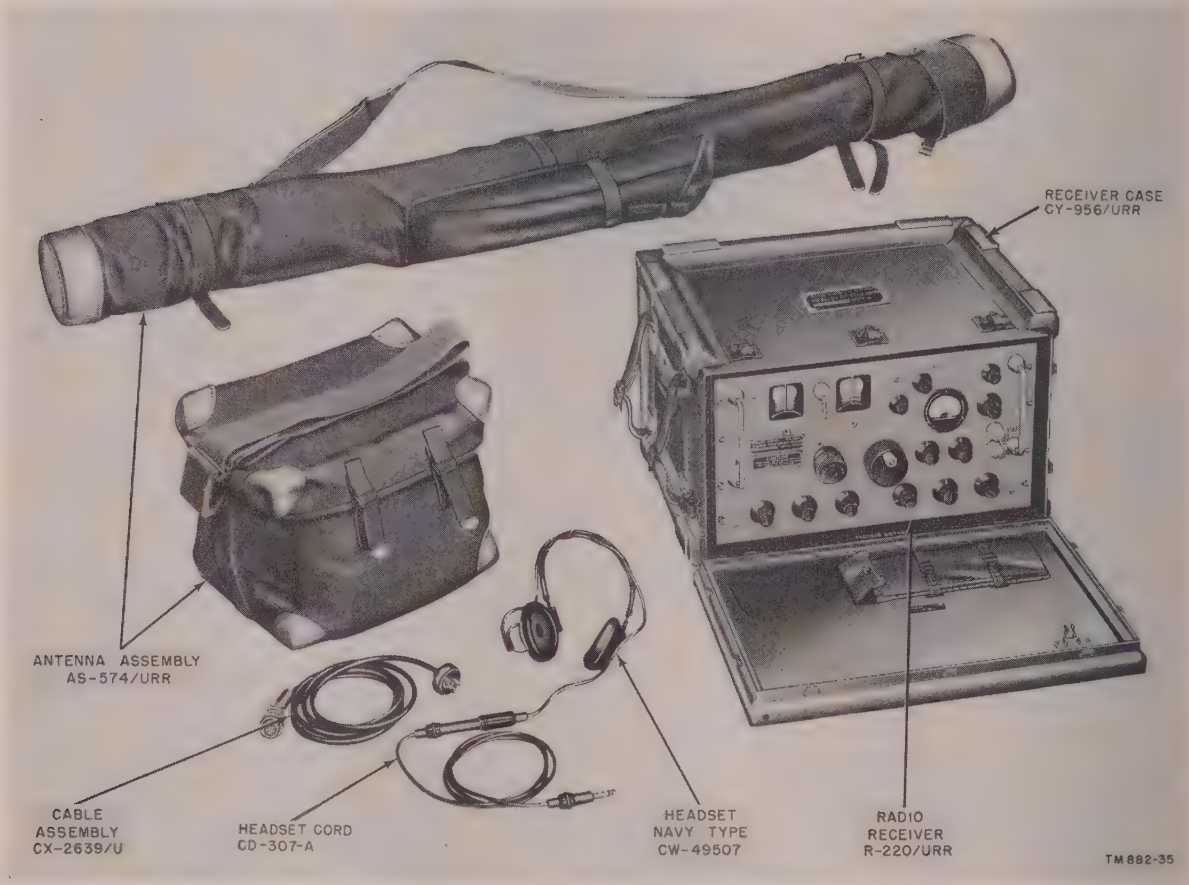

Figure 1. Radio Receiving Set AN/URR-29.

Note. This instruction book will be replaced by TM 11-882, which, when printed, will be listed in SR 310-20-4.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

This instruction book contains information necessary for the installation, operation, maintenance, and repair of Radio Receiving Set AN/URR-29 (fig. 1), and Radio Receiver R-220/URR (fig. 2).

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of material and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army), Navy Shipping Guide, Article 1850-4, and AFR 71-4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR-700-45-5.

c. AF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AFR 65-26.

d. DA Form 11-238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 27).

e. DA Form 11-239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 28).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. General. Radio Receiving Set AN/URR-29 consists of Radio Receiver R-220/URR, Receiver Case CY-956/URR, Antenna Assembly AS-574/URR, headset Navy type CW-49507, headset Cord CD-307-A, Power Cable Assembly CX-2639/U, a spare parts kit, and instruction books. Radio Receiver R-220/URR, which includes Power Supply PP-660/URR and interconnecting cables, is supplied with headset Cord CD-307-A, Power Cable Assembly CX-2639/U, a spare parts kit, and instruction books. Two transmission lines, Radio Frequency Cable Assembly CG-1079/U, 50-foot, 95-ohm twinaxial (twinax) and Radio Frequency Cable Assembly CG-718/U, 25-foot, 50-ohm coaxial (coax), are included with Antenna Assembly AS-574/URR.

b. Types of Reception. Radio Receiving Set AN/URR-29 is a compact receiving set designed for the reception and monitoring of a-m (amplitude-modulated), f-m (frequency-modulated), mcw (modulated continuous wave), and c-w (continuous wave) signals. It uses a triple-conversion superheterodyne circuit with a built-in crystal calibrator and bfo (beat-frequency-oscillator). The receiving set is adapted for a particular type of operation by setting the B.F. OSCILLATOR switch and the six-position OPERATION switch, both on the front panel of the receiver. The four main types of operation of the receiving set and the corresponding switch positions are:

(1) *A-m.* B.F. OSCILLATOR switch at OFF position; OPERATION switch at AM SQUELCH, MGC (manual gain control), or AGC (automatic gain control) position.

(2) *F-m.* B.F. OSCILLATOR switch at

OFF position; OPERATION switch at FM SQUELCH.

(3) *C-w.* B.F. OSCILLATOR switch at 0 position; OPERATION switch at either MGC or AGC position.

(4) *Mcw.* B.F. OSCILLATOR switch at OFF position; OPERATION switch at either MGC or AGC position.

c. Range of Operation. The frequency coverage of the receiver is from 20 mc (megacycles in the hf (high frequency) band to 230 mc in the vhf (very high frequency) band (on all types of reception listed in the preceding subparagraph), selected in seven bands by the BAND SELECTOR switch on the front panel, and continuously tunable within each band by the TUNING knob on the front panel.

d. Power Input. The power supplied to the radio set may be 115 or 230 volts 48-62 cps (cycles per second) a-c (alternating current), or 26 volts d-c (direct current). Provision is made in the receiver to accommodate a 26-volt dynamotor power supply in place of Power Supply PP–660/URR. By using the input voltage selector switch located at the rear of the power supply chassis, the operator can set the a-c power supply to operate on either 115 volts or 230 volts.

e. Antenna Assembly. Antenna Assembly AS–574/URR is designed for use with Radio Receiving Set AN/URR–29. The antenna consists of a broad band dipole and a sectionalized mast, with necessary accessories. The dipole is supported on the mast and may be rotated or tilted to permit optimum response for any azimuth angle of incoming signal or any angle of signal polarization. The nominal input impedance of the dipole is 95 ohms. The sectional mast may also be used as a vertical antenna. The antenna is described in TM 11–5016 (when published).

f. Conditions of Operation. Radio Receiving Set AN/URR–29 is completely portable and can be used in either fixed, semi-fixed, or portable installations. It is moisture and fungus resistant, and may be used under extreme climatic conditions, such as cold, heat, moisture, rain, and in desert areas.

4. Technical Characteristics of Radio Receiver R–220/URR

Type of receiver	Triple-conversion superheterodyne.
Type of signal received	A9 and F9.
Deviation, f-m	±75 kc maximum.
Number of tubes:	
Receiver	41 (including ballast tube RT301).
Power supply	1.
Intermediate frequencies:	
First (variable)	Band 1, 6.0942 mc; Band 2, 8.6369 mc; Band 3, 12.1884 mc; Band 4, 17.2738 mc; Band 5, 24.3767 mc; Band 6, 34.5476 mc; Band 7, 48.7535 mc.
Second (fixed)	1.75 mc.
Third (fixed)	455 kc.
I-f selectivity	10 kc, 50 kc, and 200 kc bandwidths.
Frequency range	20 to 230 mc in seven bands.
Band 1	20 to 28.5 mc.
Band 2	28.5 to 40.5 mc.
Band 3	40.5 to 57 mc.
Band 4	57 to 81 mc.
Band 5	81 to 114 mc.
Band 6	114 to 162 mc.
Band 7	162 to 230 mc.
Type of tuning	Continuous on each band, with overlap; read directly on megacycle and kilocycle dials.

Method of calibration	Built-in crystal-controlled calibration oscillator.
Calibration points	20-230 mc, in 5-mc steps.
Receiver sensitivity to produce an output of 10 mw for 10 db signal-to-noise ratio:	
A-m signals	2 uv (microvolts) or better on bands 1 through 5. 3.5 uv or better on band 6. 6.0 uv or better on band 7.
C-w signals	1.0 uv or better on bands 1 through 5. 1.5 uv or better on band 6. 2.0 uv or better on band 7.
F-m signals	6.5 uv or better on bands 1 through 6. 16 uv or better on band 7.
Squelch sensitivity	1 uv.

Audio response:

SHARP, using 800 cps band-pass filter	—6 db at 600 cps and 1,000 cps. —30 db at 400 cps and 1,200 cps.
MEDIUM, using 3,500 cps low-pass filter	200-3,500 cps, flat, ±3 db. —35 db at 4,000 cps.
WIDE, using no filter	300-3,500 cps, flat, ±1 db. 200-4,000 cps, flat, ±3 db.

Outputs:

J301	Auxiliary diode output, 5v d-c or a-f across 47,000 ohms.
J302	Auxiliary i-f output, 455 kc, 1 mw across 50 ohms.
J305	0.5 w across 600-ohm unbalanced audio output.
J306	0.5 w across 600-ohm unbalanced audio output.
TB308	
Terminals 1 and 2	0.5 w across 600-ohm unbalanced audio output.
Terminals 3 and 6	100 mw across 600-ohm balanced line, audio output.

Antenna input:

Balanced	95 ohms nominal impedance, for connecting to 95-ohm twinaxial transmission line.
Unbalanced	95 ohms nominal impedance, using adapter, for connecting to 50-ohm coaxial transmission line.

Power input requirements:

Tube heaters	26 volts a-c or d-c at 2.1 amp and 6.3 volts a-c or d-c at 3 amp.
B+ circuits	175 volts d-c at 170 ma.
Oscillator heater element	115 volts a-c at .78 amp, or 26 volts, a-c or d-c, at 3.5 amp.

Adaptability to service conditions:

Altitude	15,000 feet.
Shock and vibration	Will withstand shock in vehicles traveling over rough terrain.
Weatherproof and climate	Waterproof to depth of 6 feet (when used with Receiver Case CY–956/URR); will withstand driving rain and salt spray.

Normal operating temperature	—40° F (—40° C) to 140° F (60° C).
Height	10½ in.
Width	19 in.
Depth	14¾ in.
Weight (including power supply, but less case)	96 lb.
Weight of Receiver Case CY–956/URR	38 lb.

Power Supply PP–660/URR:

Input	115 volts a-c at 2.2 amp, 48-62 cps, or 230 volts a-c at 1.1 amp, 48-62 cps.
Electron tube	1 full-wave rectifier.
Output	115 volts a-c at .78 amp, 26 volts a-c at 2.1 amp, 6.3 volts a-c at 3 amp, and 175 volts d-c at 170 ma.
Weight	30 lb.

5. Packing and Packaging Data

a. General. Radio Receiving Set AN/URR–29 may be packed for export or for domestic shipment, the method of packing differing only in the number and type of outer containers. Radio Receiver R–220/URR may be packed separately for export or for domestic shipment. A list of the contents of all inner cartons (packages) is stenciled or labeled on each inner box; the contents of each outer container is shown on a packing list (contents) inside of the outer box. In addition, a consolidated packing list, itemizing all of the components in the shipment, will be found tacked or taped to one of the outer containers. Two orange stripes stenciled at one end of the packing case (see figure 8) indicate an export shipment. An orange spot and a number such as 1/3, 2/3, or 3/3 means that the box is part of a set (example: 2/3 indicates the second box in a set of three). The method of packing may vary somewhat from that shown, depending on the supply channel.

b. Export Packing. An export shipment of Radio Receiving Set AN/URR–29 is packed in three wooden crates (fig. 8). The first crate contains Radio Receiver R–220/URR, Receiver Case CY–956/URR, headset Navy type CW–49507, Power Cable Assembly CX–2639/U, headset Cord CD–307–A, the running spare parts and the instruction books. The second and third crates contain Antenna Assembly AS–574/URR, including cable assemblies CG–1079/U and CG–718/U. Radio Receiver R–220/URR is packed for export shipment in a single wooden crate (fig. 9). Besides the receiver, the crate contains Power Cable Assembly CX–2639/U, headset Cord CD–307–A, running spare parts and the instruction books.

c. Domestic Packing. A domestic shipment of Radio Receiving Set AN/URR–29 is packed in four containers (fig. 12) as follows: a cleated fiberboard box containing Radio Receiver R–220/URR and Receiver Case CY–956/URR; a cardboard carton containing Power Cable Assembly CX–2639/U, headset Cord CD–307–A, headset Navy type CW–49507, running spare parts and the instruction books; a cardboard carton containing mast sections and dipoles for Antenna Assembly AS–574/URR; and a wooden crate containing accessories for the antenna assembly. Radio Receiver R–220/URR is packed for domestic shipment in two containers (fig. 13). One of these is a cleated fiberboard box containing Radio Receiver R–220/URR. The other is a cardboard carton containing Power Cable Assembly CX–2639/U, headset Cord CD–307–A, running spare parts and the instruction books.

d. Packaging. The materials used for the inner cartons, or *packages,* are the same for both export and domestic shipment. Typical packages are shown in figures 10 and 11. The cartons and the tape used for packaging are both waterproof. Fillers are used to protect the equipment from shock. The contents of each package is stenciled or labeled on the outside of the box.

e. Case Contents and Dimensions. The following charts list the case contents and dimensions for both export and domestic shipments of Radio Receiving Set AN/URR–29 and Radio Receiver R–220/URR.

Note. Items may be packaged in a different manner from that shown, depending on supply channels.

(1) *Export shipment, Radio Receiving Set AN/URR–29* (fig. 8).

Case	Inside dimensions (in.)	Contents
1 of 3	20¼ x 17⅜ x 35¼	Radio Receiver R–220/URR, Receiver Case CY–956/URR, headset Navy type CW–49507, Power Cable Assembly CX–2639/U, running spare parts kit and instruction books.
2 of 3	8⅛ x 10⅛ x 70¼	Antenna Assembly AS–574/URR dipoles and mast sections.
3 of 3	11 11/16 x 13 5/16 x 18¼	Antenna Assembly AS–574/URR transmission lines, guy ropes, brackets, tools, hardware.

(2) *Domestic shipment, Radio Receiving Set AN/URR–29* (fig. 12).

Case	Inside dimensions (in.)	Contents
1 of 4	20¼ x 17⅜ x 26 11/16	Radio Receiver R–220/URR and Receiver Case CY–956/URR.
2 of 4	14¾ x 14⅜ x 14⅜	Headset Navy type CW–49507, headset Cord CD–307–A, Power Cable Assembly CX–2639/U, running spare parts kit, and instruction books.
3 of 4	7 x 9⅜ x 67¾	Antenna Assembly AS–574/URR dipoles and mast sections.
4 of 4	10 15/16 x 12 9/16 x 15¼	Antenna Assembly AS–574/URR transmission lines, guy ropes, brackets, tools, and hardware.

(3) *Export shipment, Radio Receiver R–220/URR* (fig. 9).

Case	Inside dimensions (in.)	Contents
1 of 1	19¾ x 13 13/16 x 31⅜	Radio Receiver R–220/URR, headset Cord CD–307–A, Power Cable Assembly CX–2639/U, running spare parts kit, and instruction books.

(4) *Domestic shipment, Radio Receiver R–220/URR* (fig. 13).

Case	Inside dimensions (in.)	Contents
1 of 2	21⅞ x 12⅞ x 21⅞	Radio Receiver R–220/URR.
2 of 2	10¾ x 14⅜ x 14⅜	Headset Cord CD–307–A, Power Cable Assembly CX–2639/U, running spare parts kit, and instruction books.

6. Table of Components (figs. 1, 5, 6, and 7)

Component	Quantity	Height (in.)	Depth (in.)	Length (in.)	Volume (cu. in.)	Unit weight (lb)
Radio Receiver R–220/URR.	1	10½	14¾	19	2942	100
Power Supply PP–660/URR.	1	6¼	5¾	11½	413	30
Receiver Case CY–956/URR.	1	17⅛	13¼	22	5028	38
Antenna Assembly AS–574/URR dipoles and mast sections.	1	9⅜	7	67¾	4205	
Antenna Assembly AS–574/URR transmission lines and connectors, guy ropes, brackets, tools and hardware.	1	10	12⁹⁄₁₆	15¼	1906	
Headset Navy type CW–49507.	1					¾
Kit, running spares.	1	9½	4½	13¼	566	
Headset Cord CD–307–A.	1			67		
Power Cable Assembly CX–2639/U.	1			96		
Instruction books for Radio Receiving Set AN/URR–29 and Radio Receiver R–220/URR.	2	2	11	8½	70	3
Instruction books for Antenna Assembly AS–574/URR.	2	½	11	8½	47	

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisitioning of spare parts.

Section III. DESCRIPTION OF COMPONENTS

7. Description of Antenna Assembly AS–574/URR

The antenna assembly consists of dipole radiators, mast sections, two transmission lines and connectors, guy ropes, brackets, tools, and hardware. Antenna Assembly AS–574/URR is described separately in TM 11–5016 (when published).

8. Description of Receiver Case CY–956/URR

(figs. 2, 3, and 4)

Caution: Care must be exercised when releasing the latch strikes on Receiver Case CY–956/URR because they snap back quickly and may catch the fingers.

a. This case is designed to enclose Radio Receiver R–220/URR. For access to the front panel controls, remove the front cover of the case by releasing the ten latch strikes (fig. 2).

b. The front cover of Receiver Case CY–956/URR is equipped with a rubber gasket which fits the body edges of the case to make a waterproof seal. The case can be moved about by means of two spring handles which are recessed in the mechanism boxes on the sides. Two straps fastened to each side aid in holding the case rigidly in place when the receiver is used in a moving vehicle. The receiver rests on shock mounts inside the case and is held in place by means of eight knurled thumbscrews, four on each side of the front panel. These screws must be disengaged before attempting to remove the receiver from the case. The receiver may then be pulled out by means of the two front handles. Figure 3 shows the two rails on which the receiver slides when being removed. The case is lined with truss paneling which aids in holding the receiver rigidly in place.

Figure 2. Radio Receiver R–220/URR and Receiver Case CY–956/URR.

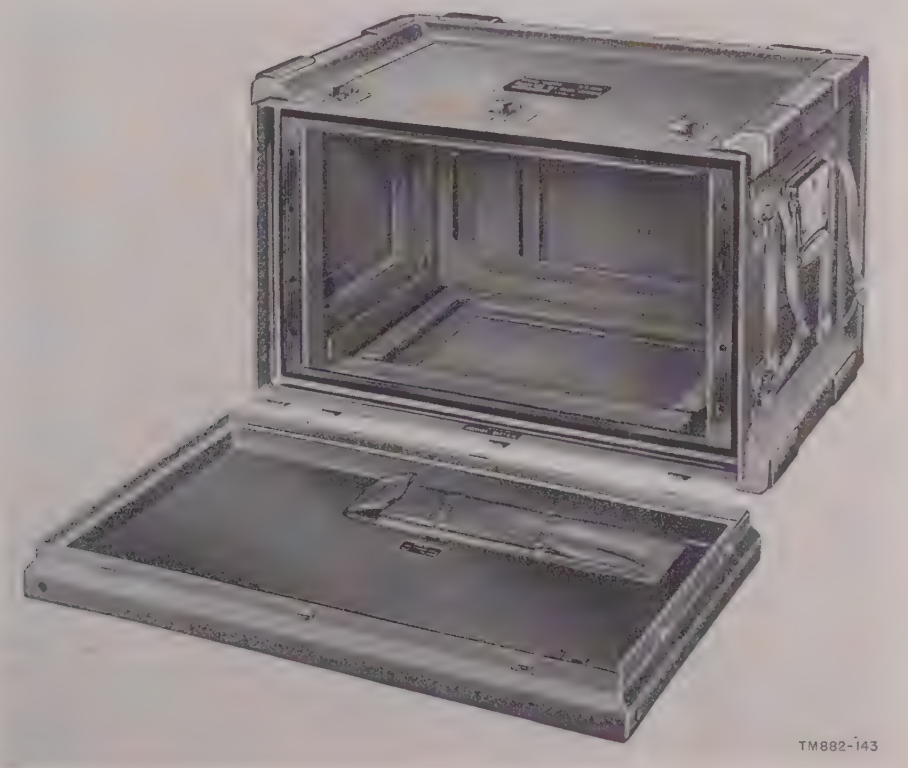

Figure 3. Receiver Case CY–956/URR, part of Radio Receiving Set AN/URR–29.

c. The controls and jacks at the rear of the receiver can be reached, while the receiver remains in the case, by means of an aperture in the back of the case. When this aperture is not being used, it is covered by an access cover. This cover is fastened to the case by a chain but may be removed entirely from the aperture. The cover is waterproofed by means of a rubber gasket around the edge, and fits tightly against the case when locked in position.

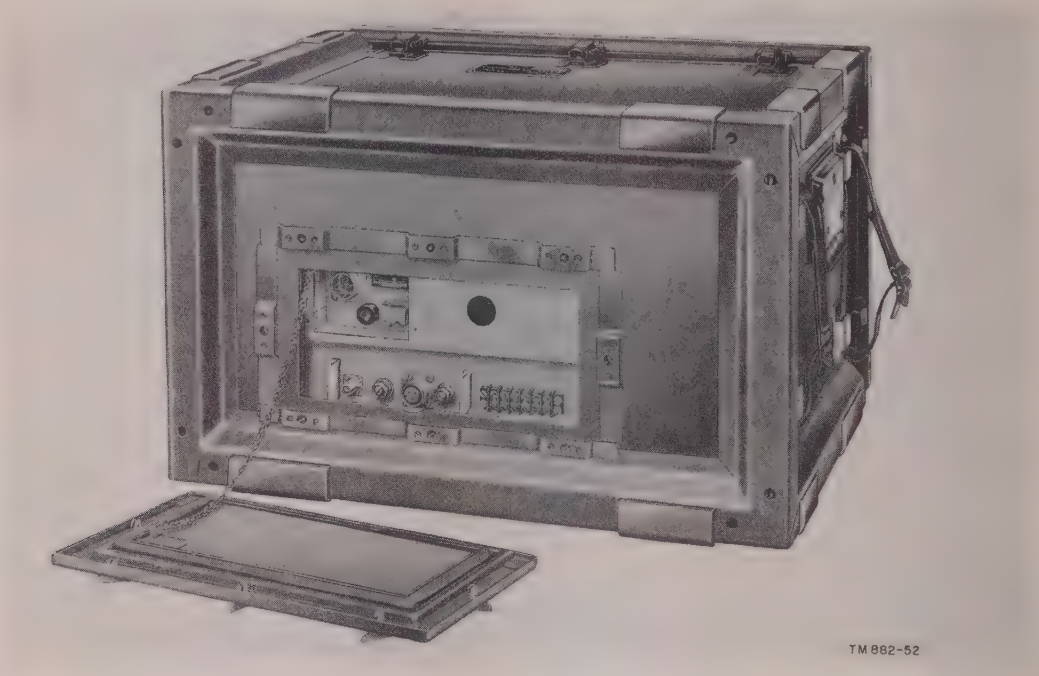

Figure 4. Receiver Case CY–956/URR, showing access to rear of Radio Receiver R–220/URR.

9. Description of Radio Receiver R–220/URR

(fig. 2)

a. Radio Receiver R–220/URR is a triple conversion superheterodyne receiver designed to receive a-m, c-w, mcw, and f-m signals in the frequency range of 20 mc to 230 mc, with provision for working with all the various types of antenna systems used for communications, intercept, and direction finding purposes. Provision is made for output connections of the receiver to standard loudspeakers, headphones, and wire lines. Provision is also made for output connections with standard equipments as required for diversity reception, direction finding, carrier-shift radio teletype, facsimile, signal analysis, single side-band reception and the like.

b. Mechanically, the receiver is a panel and chassis assembly which may be either (1) rack mounted, in which case it is protected by a dust cover, or (2) mounted in Receiver Case CY–956/URR, an immersion-proof housing capable of withstanding immersion in 6 feet of water.

c. The receiver may be used with either a 100-ohm balanced antenna or a 50-ohm unbalanced (single-ended) antenna. An antenna adapter is provided for use with the unbalanced antenna input, and an antenna trimmer is used with either input circuit to satisfy the impedance requirements.

d. Two audio-output channels are provided, one for local monitoring and one for remote monitoring. Adjustment of the level or loading of the local channel will not affect the remote channel; however, adjustment of the level or loading of the remote channel will affect the local channel.

e. Special features include a squelch circuit that disables the audio amplifier when no incoming carrier is present and which energizes the audio amplifier when a carrier is present.

f. The receiver contains a push-pull r-f (radio-frequency) amplifier, three oscillators, three mixers, agc and mgc circuits, an audio response filter, a selectivity filter, one variable i-f stage, eight fixed i-f stages, two limiters, a squelch circuit, a discriminator, an a-m detector circuit, a bfo circuit, a noise limiter circuit, two audio-amplifier circuits, a p-a (power-amplifier) circuit, an auxiliary diode circuit, a built-in crystal calibrator and buffer, five multiplier-buffer circuits, and a metering circuit. The chart below lists the tube types used in the receiver and their functions.

Circuit symbol	Type	Function
V101	5840	R–f amplifier.
V102	5840	R–f amplifier.
V103	5840	Third multiplier buffer.
V104	5840	First mixer.
V105	5718	Third multiplier.
V106	5718	Third multiplier.
V107	5718	Second multiplier.
V108	5718	Second multiplier.
V109	5840	First multiplier.
V110	5840	First high-frequency oscillator.
V111	6AU6	Second high-frequency oscillator.
V112	6AU6	Second mixer.
V113	5749/6BA6W	First i-f amplifier.
V114	6AU6	Calibrator buffer.
V115	6AU6	Calibrator oscillator.
V116	5840	First hfo buffer.
V301	6AU6	Third mixer.
V302	6AU6	2205-kc oscillator (third hfo).
V303	5726/6AL5W	(A) Mgc diode. (B) Not used.
V304	5749/6BA6W	First 455-kc i-f amplifier.
V305	5749/6BA6W	Second 455-kc i-f amplifier.
V306	5749/6BA6W	Third 455-kc i-f amplifier.
V307	5749/6BA6W	Fourth 455-kc i-f amplifier.
V308	6AU6	F-m i-f amplifier.
V309	6AU6	First limiter.
V310	6AU6	Second limiter.
V311	5726/6AL5W	Discriminator.
V312	6AU6	Noise amplifier.
V313	5726/6AL5W	Noise rectifier.
V314	5749/6BA6W	A-m i-f amplifier.
V315	5726/6AL5W	(A) A-m detector. (B) Noise suppressor.
V316	5726/6AL5W	Agc diode.
V317	12AT7	(A) Squelch. (B) First audio amplifier.
V318	5749/6BA6W	First auxiliary i-f amplifier.
V319	5749/6BA6W	Second auxiliary i-f amplifier.
V320	5726/6AL5W	(A) Auxiliary diode. (B) Not used.
V321	6AU6	Beat frequency oscillator.
V322	6AK6	Second audio amplifier.
V323	OB2	Voltage regulator.
V324	6AK6	Audio power amplifier.
V601	5R4WGY	High voltage rectifier.

Note. (A) is first half of tube; (B) is second half.

10. Description of Power Supply PP–660/URR (fig. 5)

The power supply is designed to provide the required operating voltages for the receiver when the proper power source is used. Either 115 volts or 230 volts may be used; a toggle switch located at the rear of the power supply changes the internal connections to conform

with whichever of these two source voltages is available. The switch arm is held in place by a spring metal bracket, with slots located in the two switch-arm positions. The input voltage selector switch, power input jack, line fuse, and spare fuse are all accessible through an opening in the receiver dust cover. In order to reach the rectifier tube or the antenna adapter, however, the dust cover must be removed. When using an unbalanced antenna (par. 11*c*(2)), the antenna adapter must be removed from its position on the power supply chassis and connected between antenna input jack J107 and the 50-ohm antenna transmission line, CG–718/U. When it is necessary to service the power supply, it must be removed from the main unit as directed in paragraph 17*d*, and the base plate must be taken off. Servicing of the power supply is described in chapters 4 and 6.

11. Description of Cables
(fig. 6)

a. General. A set of cables is supplied with Radio Receiving Set AN/URR–29 for connecting the units to the external power source, the headset, and the antenna system, and for interconnecting the units. These cables are illustrated in figure 6. Refer to figures 25, 123, and 124 for the cabling of the radio set.

b. Power Cables.

(1) An 8-foot power cable, CX–2639/U, which is supplied with the radio set, is used to bring a-c power from an outlet receptacle to the input of the radio receiver. The cable is made up of two heavy-duty, rubber-covered wires. It has a two-prong plug at one end; the other end is fitted with a five-contact plug and a threaded cable clamp for connecting to power supply input jack J603.

(2) Two interconnecting power cables, W302 and W304, are used to interconnect the main unit, r-f unit, and power supply. These cables are similar in appearance, each having identical polarized plug connectors at both ends and identical shielding and plastic covering, but they differ in overall length

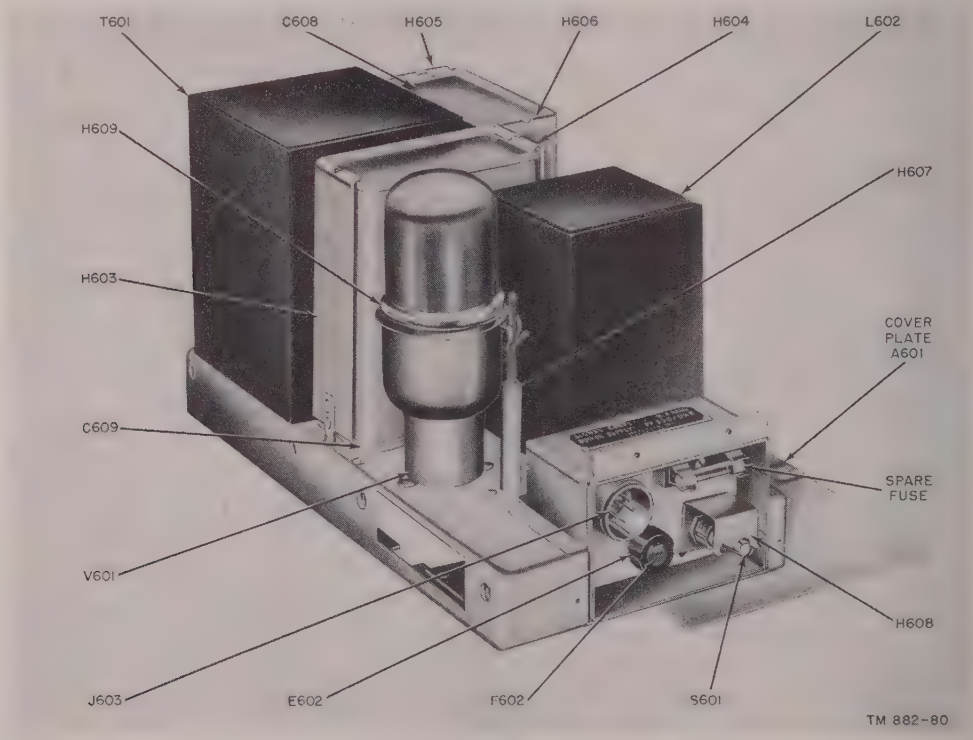

Figure 5. Power Supply PP–660/URR, part of Radio Receiver R–220/URR.

and number of conductors. W304 is an 18-inch cable used to connect the power supply to the main unit. It consists of nine stranded copper wires (seven No. 18 A.W.G. and two No. 22 A.W.G.). W302, the 22-inch cable, interconnects the main unit and r-f unit. It consists of eleven stranded copper wires (five No. 18 A.W.G. and six No. 22 A.W.G.).

c. R-f Cables. Three radio-frequency cables are supplied with Radio Receiving Set AN/URR–29. One is an i-f signal cable, W301, interconnecting the main and r-f units (fig. 21) of the receiver; the other two cables are the transmission lines, CG-1079/U and CG–718/U.

(1) W301 is a 7-inch length of RG–62A/U coaxial cable which has a characteristic impedance of 93 ohms and consists of a single solid No. 22 A.W.G. copper-covered steel wire with plain copper shielding. This cable is fitted with a UG–260/U plug (P307) at one end, and a UG–692/U plug (P306) at the other end. P306 is plugged into J106 (the 1.75 mc output jack located on the r-f unit), the cable passing through a hole in the bottom dust cover of the r-f unit and through another hole at the rear of the main unit. The free end of the cable (P307) plugs into J307 (the 1.75 mc filter jack) located on the bottom of the main unit.

(2) Two transmission lines are supplied with the receiving set, CG–1079/U to be used with a balanced antenna and CG–718/U to be used with an unbalanced antenna. The balanced antenna consists of the dipole elements supplied with Antenna Assembly AS–574/URR. The mast of the antenna

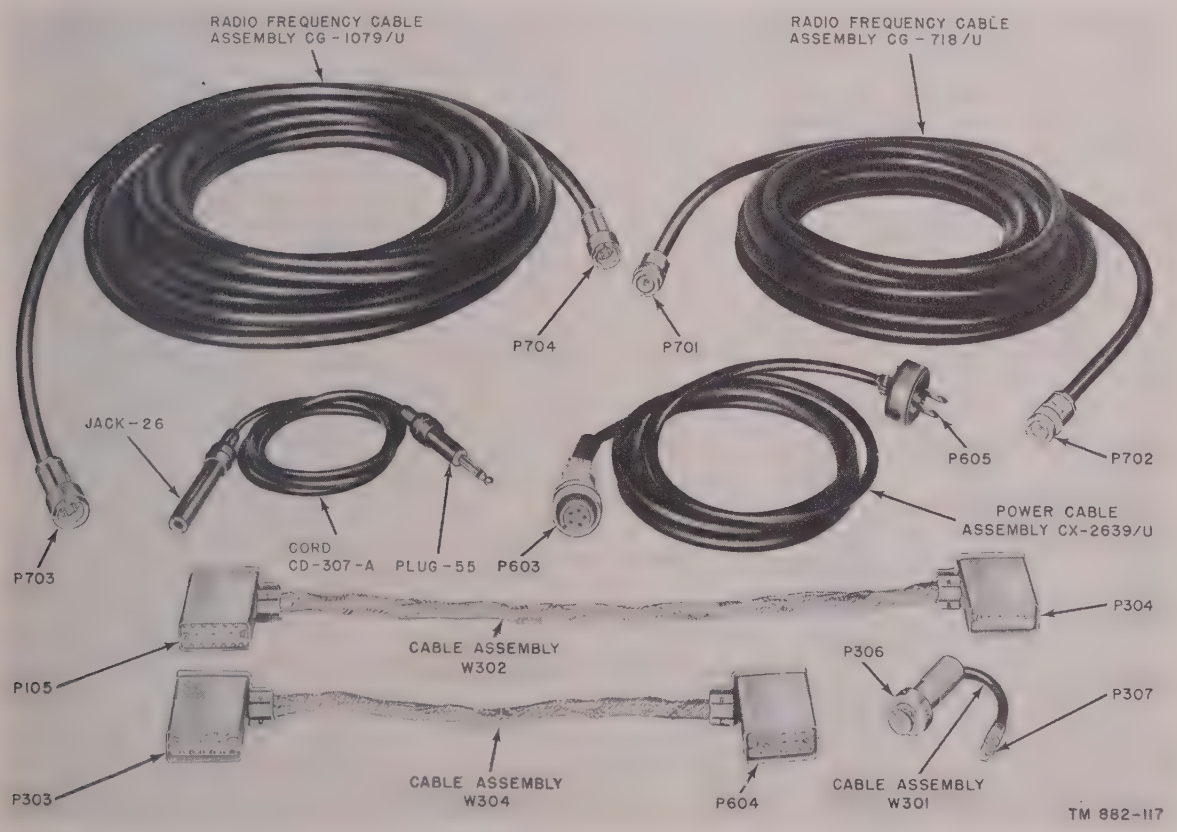

Figure 6. Radio Receiving Set AN/URR–29 cables.

assembly is used as a vertical radiator to comprise the unbalanced antenna. CG–1079/U is a 50-foot cable consisting of RG–22B/U, 95-ohm twinax with polarized male plug connectors, P703 and P704, at each end. This cable connects the antenna input, J107, directly with the dipole antenna head, J702. The CG–718/U is a 25-foot cable consisting of RG–8A/U (50-ohm coax) with polarized male plug connectors, P701 and P702, at each end. This cable connects the antenna input, J107, through the antenna adapter, E101, to the coaxial output receptacle J701 at the base of the antenna mast. See TM 11–5016 (when published) for antenna assembly and installation.

d. Headset Cord CD–307–A. Cord CD–307–A is a general purpose headset cord consisting of two color-coded insulated conductors. It is fitted with a Plug PL–55 on one end for connecting with one of the AUDIO OUTPUT jacks (J305, J306) of the receiver; the other end is fitted with a Jack JK–26, for connecting with headset Navy type CW–49507 (par. 12). The cord, which is packaged with Power Cable Assembly CX–2639/U, is 5 feet, 7 inches long.

12. Description of Headset Navy Type CW–49507
(fig. 7)

Note. Headset Cord CD–307–A is not a part of headset Navy type CW–49507.

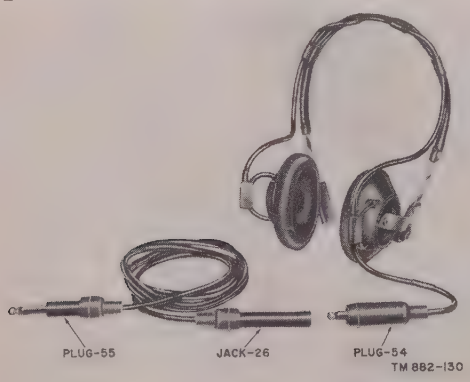

Figure 7. Headset Cord CD–307–A and headset Navy type CW–49507.

This headset is designed especially for use under the standard infantry metal helmet or the standard armored vehicle crash helmet. For this reason the headband is essentially a covered flat spring steel band equipped with the necessary cording and connecting plug. The headset assembly is connected to the radio receiver by inserting Plug PL–54 on the end of the cord into Jack JK–26 on Cord CD–307–A. The impedance of the headset assembly is 600 ohms, consisting of two wafer-type, series-connected 300-ohm receivers, equipped with synthetic rubber ear cushions. The headband should be adjusted to the head by positioning the ear cushions to minimize external noise. The headset is adjusted by sliding the bracket elements up or down on the headband within the plastic cover. At the lower extremities of the right-hand and left-hand sliding brackets are mounting studs to which Microphone Assembly Navy type 51071 may be attached.

13. Description of Running Spare Parts

A kit of running spares is supplied with Radio Receiver R–220/URR and with Radio Receiving Set AN/URR–29. The items included in the kits are the same in either case, differing only in quantity. Spares for both receiver and power supply are packed in the same carton with Radio Receiver R–220/URR in the case of export shipments. When packed for domestic shipment, however, the spare parts kit is included in a separate carton along with the cables and instruction books. (See chapter 2 for instructions on uncrating, unpacking, and checking equipment.) Spares are provided for normally expendable items such as tubes, pilot lamps, and fuses. Following is a list of running spares:

Note. Spares for Antenna Assembly AS–574/URR are packed with the antenna assembly.

Item	Equipment	
	Radio Receiving Set AN/URR–29	Radio Receiver R–220/URR
Fuse, 3–ampere, 250–volt, type 3AG.	5	4
Lamp, min. bay., 14.4v, 1 amp, G.E. No. 1813.	1	2
Tube, ballast regulator, type 1HTF10.	2	1

Item	Equipment	
	Radio Receiving Set AN/URR–29	Radio Receiver R–220/URR
Tube OB2	1	1
Tube 5R4WGY	1	1
Tube 5718	2	2
Tube 5840	4	3
Tube 6AK6	1	1
Tube 5726/6AL5W	3	2
Tube 6AU6	3	4
Tube 5749/6BA6W	3	3
Tube 12AT7	1	1
Crystal Unit CR–18/U, 5.000 mc.	1	1
Crystal Unit CR–18/U, 2.205 mc.	1	1
Crystal Unit CR–18/U, 7.8442 mc.	1	1
Crystal Unit CR–18/U, 6.8869 mc.	1	1
Crystal Unit CR–18/U, 10.4384 mc.	1	1
Crystal Unit CR–23/U, 15.5238 mc.	1	1
Crystal Unit CR–23/U, 22.6267 mc.	1	1
Crystal Unit CR–23/U, 32.7976 mc.	1	1
Crystal Unit CR–23/U, 47.0035 mc.	1	1

14. Additional Equipment Required

a. The following items are *not* supplied as a part of Radio Receiving Set AN/URR–29, but are required for its installation and operation:

(1) Suitable power source.

(2) Speaker or extra headsets (optional).

b. The following items are *not* supplied as a part of Radio Receiver R–220/URR, but are required for its installation and operation:

(1) Suitable antenna or antenna system.

(2) Suitable power source.

(3) Speaker or headset.

(4) Carrying case or rack.

CHAPTER 2
INSTALLATION AND CONNECTIONS

15. Siting

a. Exterior Requirements. The best location for radio equipment depends on the tactical situation and local conditions, such as the following: the need to house the equipment where its shelter cannot be seen; the type of housing available; possible installation in a vehicle; the terrain; and the need of easy access for messengers. Signals will be received from a greater distance by Radio Receiver R–220/URR if the antenna is high and clear of hills, buildings, cliffs, densely wooded areas, and other obstructions. Depressions, valleys, and other low places are poor locations for radio reception because the surrounding high terrain absorbs r-f energy. Weak or otherwise undesirable signals may be expected if the set is operated under or close to steel bridges, underpasses, power lines, hospitals, or power units. Normally, reception over water is better than over land. See that drainage is adequate to prevent flooding the interior of the shelter. If the equipment is part of a communication center but is not installed within the center, locate the equipment nearby. In locating the antenna, avoid obstructions which are more than 2 degrees above the horizontal plane of the antenna in the direction of desired reception. This is approximately 200 feet at a distance of 1 mile from the antenna.

b. Interior Requirements. The shelter for the equipment must meet the following requirements:

(1) The floor must be capable of sustaining the weight of the equipment in a level position without vibration.

(2) Sufficient space must be available for possible repair work, for connections to the audio output terminals, and for input voltage selector switch operation. Except for these limitations, the receiver may be located anywhere convenient to the transmission lines and external power connections.

(3) Adequate lighting for day and night operation must be provided. Place the receiver so that the panel designations may be read easily by the operating personnel. Artificial lighting other than that supplied by the DIAL LIGHT of the receiver itself should be provided by light bulbs so placed that the light falls directly on the panel. A portable drop lamp and extension cord are convenient assets for both operating and maintenance personnel.

16. Uncrating and Unpacking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 19.

a. General. Equipment may be shipped in export packing cases or in domestic packing cases and, sometimes, in its own carrying case. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the permanent or semipermanent installation of the equipment. The instructions in subparagraph *b* below apply to equipment shipped in export packing cases, and the instructions in subparagraph *d* below, to equipment in domestic packing cases. Aside from checking to make sure that all carrying cases are present and that the equipment is undamaged, no special unpacking and uncrating procedures are necessary.

Caution: Be careful in uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged, a complete overhaul might be required, or the equipment might be rendered useless.

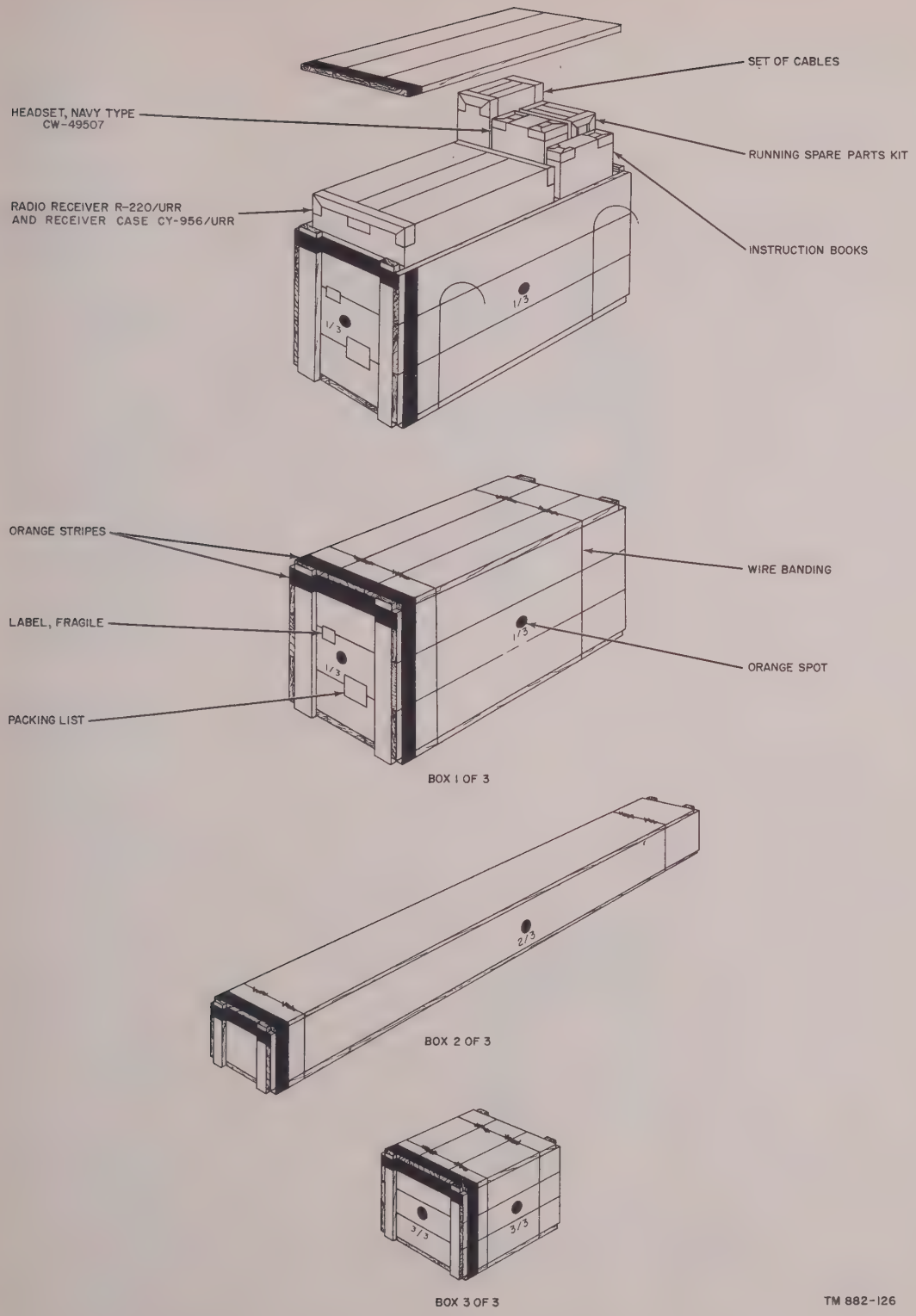

Figure 8. Radio Receiving Set AN/URR–29, packed for export shipment.

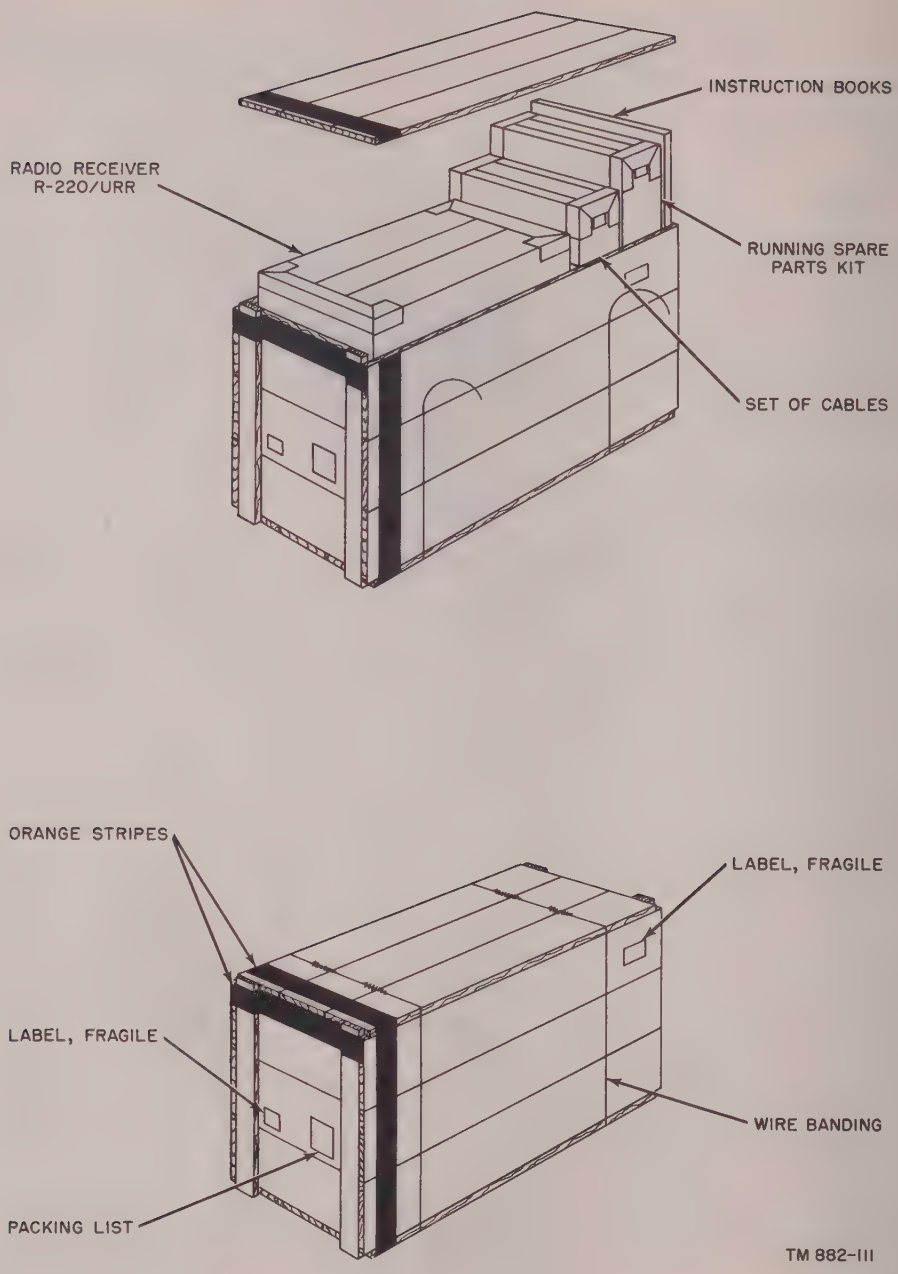

Figure 9. Radio Receiver R–220/URR, packed for export shipment.

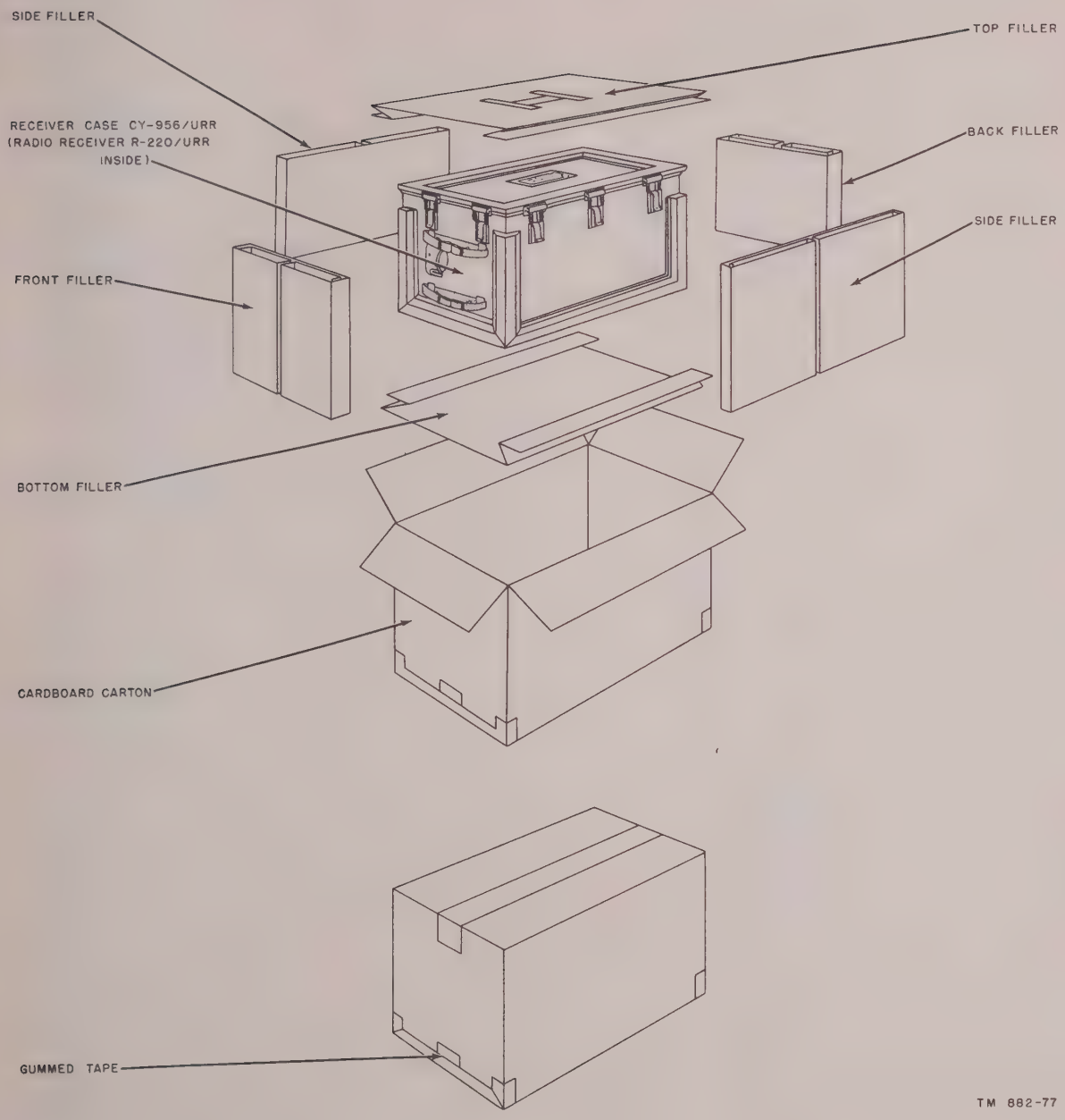

Figure 10. Packing and packaging of Radio Receiving Set AN/URR–29.

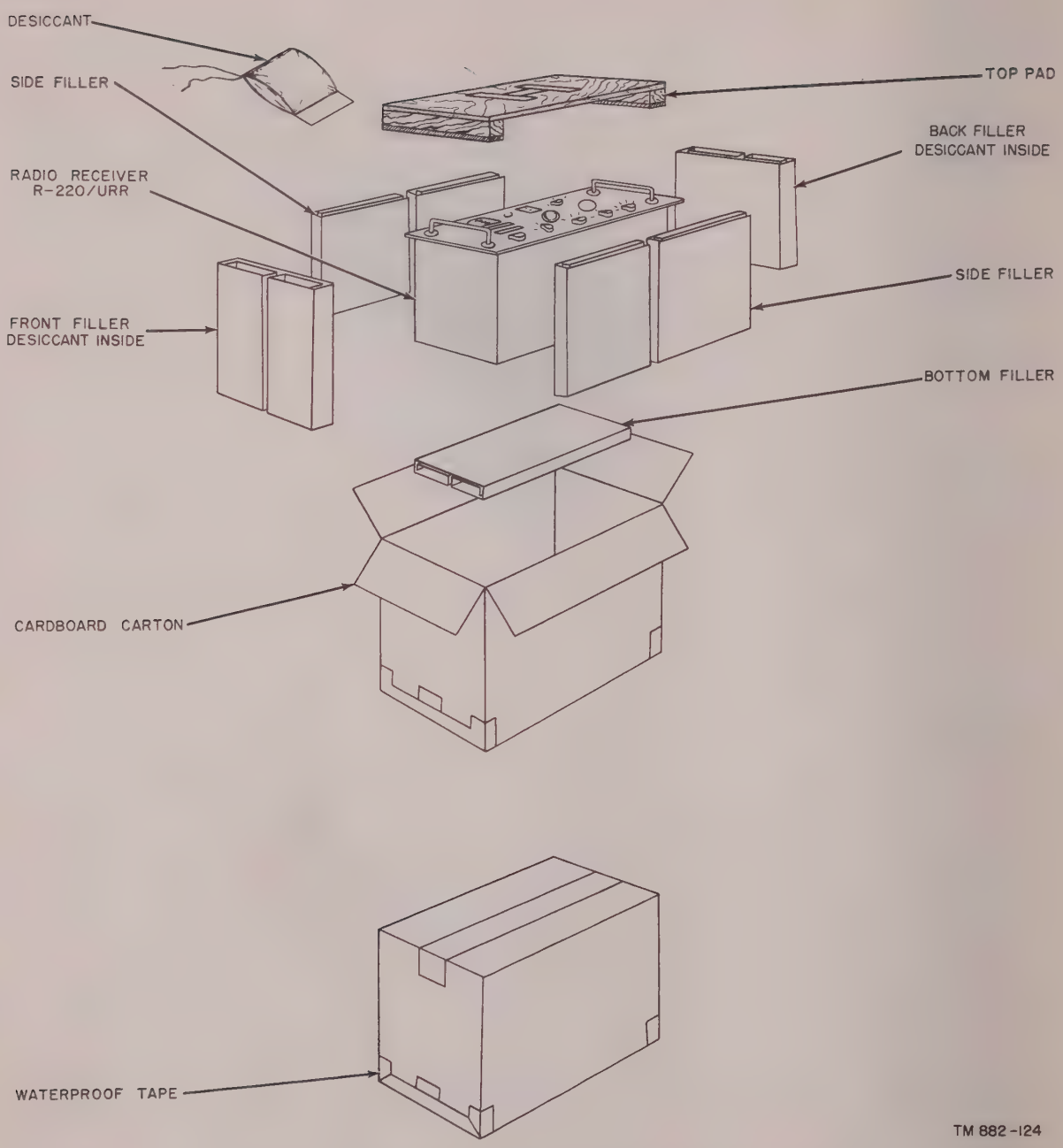

Figure 11. Packing and packaging of Radio Receiver R-220/URR.

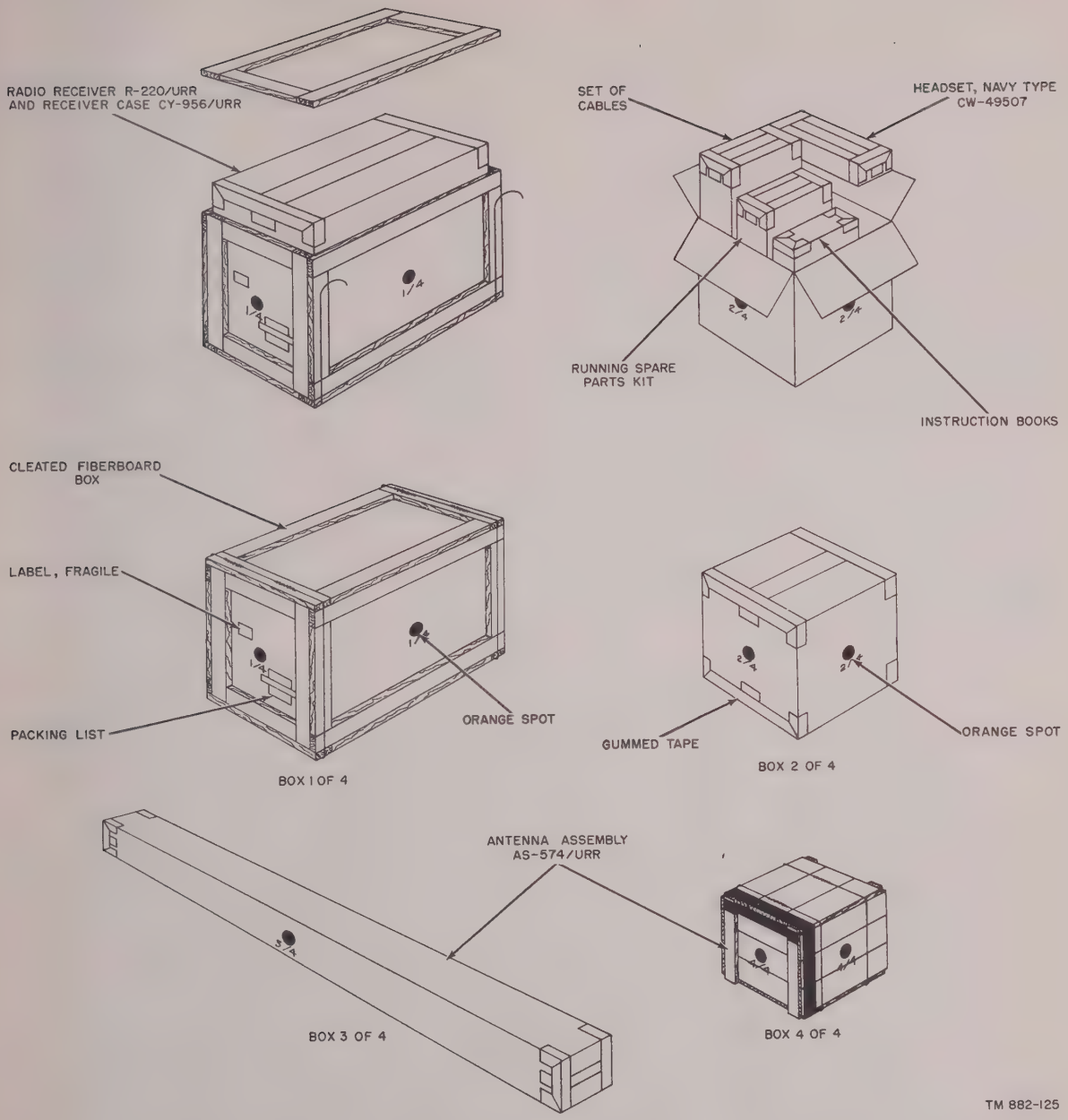

Figure 12. Radio Receiving Set AN/URR–29, packed for domestic shipment.

b. Step-by-step Instructions for Uncrating and Unpacking Export Shipments (figs. 8 and 9).

(1) Place the packing case as near the operating position as convenient.

(2) Cut and fold back the steel banding wire.

(3) Remove the nails with a nail puller. Remove the top and one side of the packing case. Do not attempt to pry off the sides and top; the equipment may be damaged.

(4) Remove the waterproof container or

moistureproof barrier and any excelsior or corrugated paper.

(5) Remove the equipment from its inner case and place it on the workbench or near its final location.

(6) Inspect the equipment for possible damage incurred during shipment (par. 17).

(7) Check the contents of the packing case against the master packing slip.

c. Opening Cardboard Carton and Waterproof Barrier (figs. 10 and 11). No special instructions are needed for opening the waterproof paper barrier and removing the equipment from the cardboard carton. Check the contents against the master packing slip.

d. Unpacking Domestic Packing Cases (figs. 12 and 13). Radio equipment may be received in domestic packing cases. The instructions given in subparagraph *b* above apply also to radio equipment received in domestic packing cases. Open the cartons that protect the equipment; if heavy wrapping paper has been used, remove it carefully and take out the components. Check the contents of the packing case against the master packing slip.

Note. Save the original packing cases and containers from both export and domestic shipments. They can be used again when the equipment is repacked for storage or shipment.

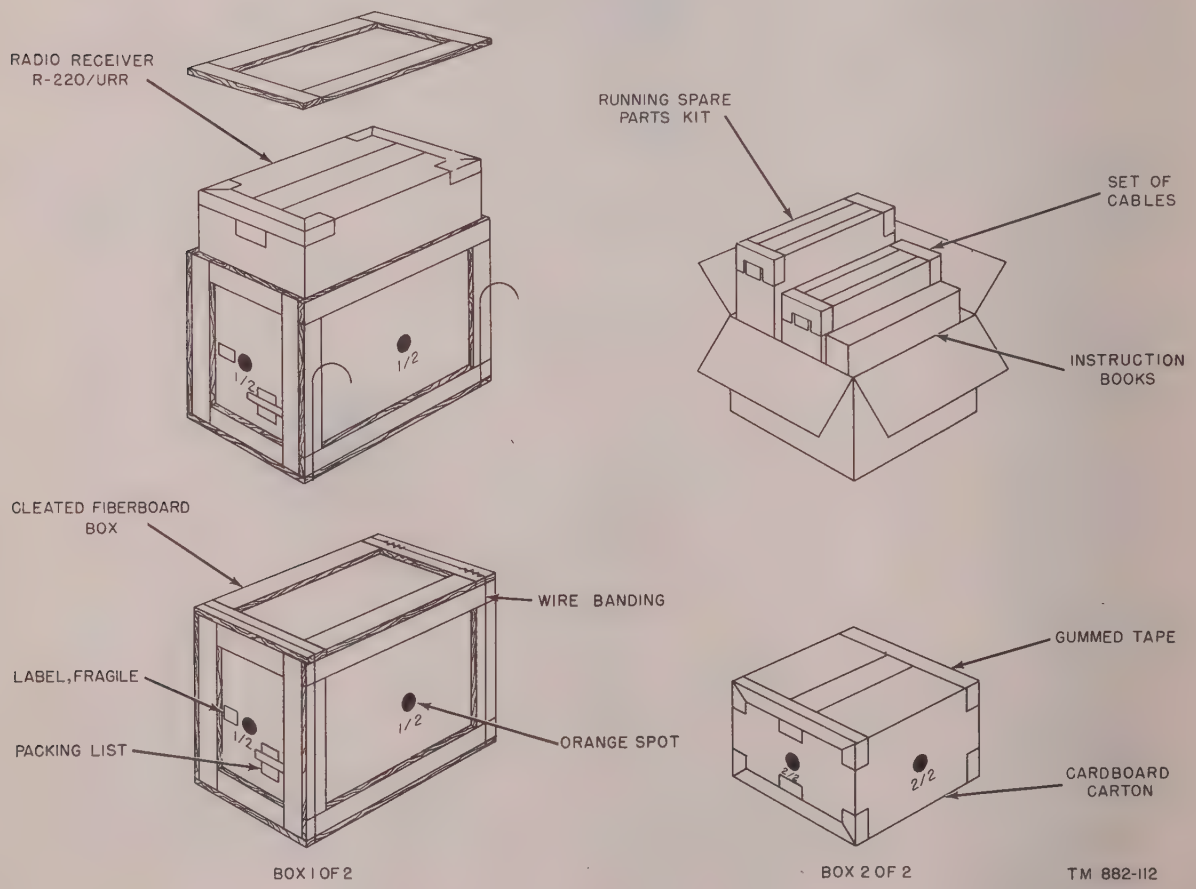

Figure 13. Radio Receiver R-220/URR, packed for domestic shipment.

17. Preliminary Disassembly of Radio Receiver R–220/URR

a. General. Before the equipment can be completely checked for possible damage incurred during shipment, it must be partly disassembled. Further disassembly procedure, required for servicing and maintenance of the equipment, will be found in chapter 6.

b. Interconnection of Units (figs. 14 and 15). Radio Receiver R–220/URR is made up of three major components: the r-f unit, the main (base) unit, and the power supply unit, PP–660/URR. These three units are interconnected by two power cables and one coaxial cable. The coax connects the r-f unit with the main unit. The power supply and main unit are interconnected by a power cable on the right-hand side of the receiver (see fig. 14) ; the main unit and r-f unit are interconnected by a similar cable on the left-hand side of the receiver (see fig. 15). Before attempting to disassemble the receiver units, always disengage both power cables from their recessed jacks and remove the coaxial cable from the jacks to which it is connected in the main and r-f units.

Note. A spanner wrench and a hex wrench are fastened to the main unit at the right-hand side of the receiver. These tools are used for removing front panel water seals when disassembling the receiver.

c. Removal of Dust Cover (fig. 16). A dust cover is fastened by means of 16 screws to the top and rear of the receiver. Access can be had to the alining tool and wrenches and to all controls and jacks at the rear of the receiver, while this dust cover is in place. The dust cover and base plate must be removed, however, before the power supply or the r-f unit can be withdrawn from the main unit. To remove the dust cover, release the eight screws which fasten it to the top of the main unit, the four screws which fasten it to the rear of the main unit, and the four screws which fasten it to the rear of the power supply unit. With the dust cover removed, access is also had to the rectifier tube and to the antenna adapter. To remove the base plate, release the eighteen screws which hold the base plate to the bottom of the main unit.

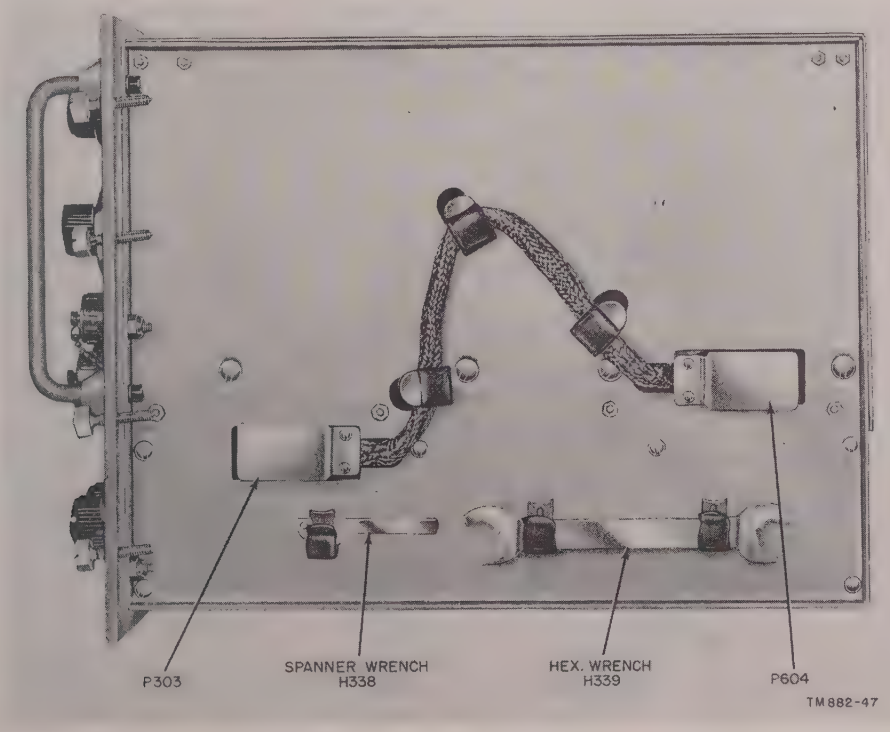

Figure 14. Radio Receiver R–220/URR, cable connections on power supply side of main unit.

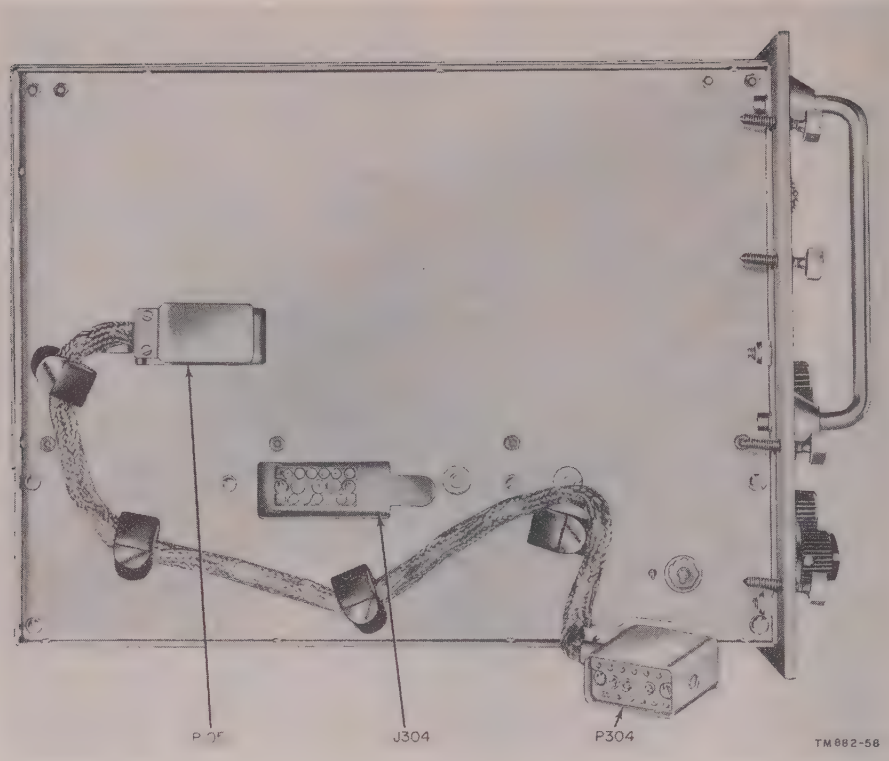

Figure 15. Radio Receiver R–220/URR, cable connections on r-f side of main unit.

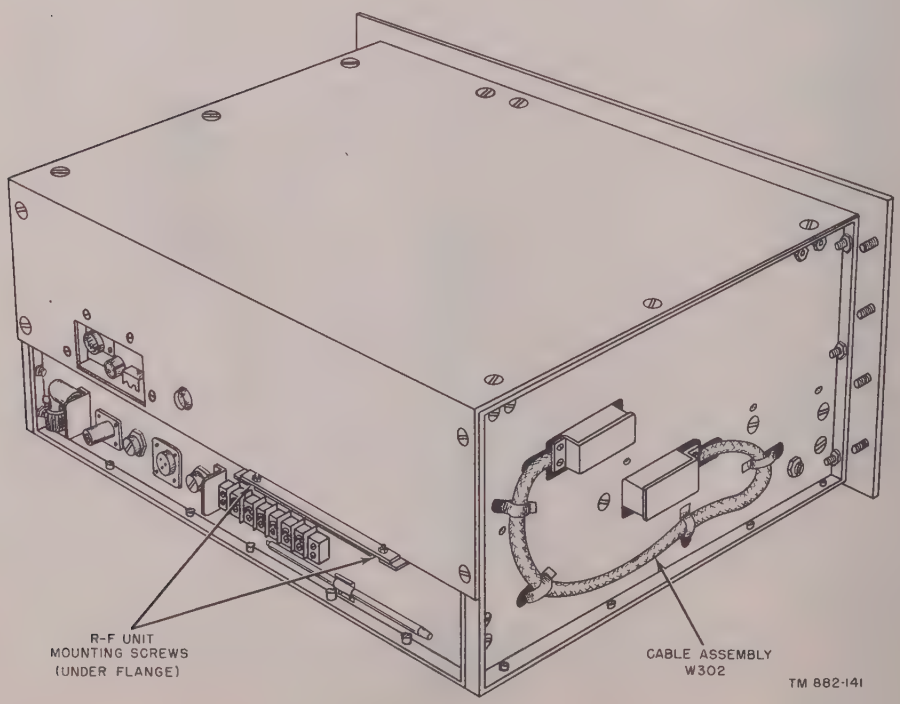

Figure 16. Radio Receiver R–220/URR, showing dust cover removal.

d. Removal of Power Supply Unit (fig. 17). Observe the following procedure in removing the power supply unit from the receiver:

(1) Remove the three screws which hold the power supply to the middle guide rail of the main unit. These screws are accessible from the bottom of the main unit chassis.

(2) Remove the four screws which hold the power supply to the right-hand side of the main unit.

(3) Disengage interconnecting power cable assembly W304 from the power supply unit.

(4) Slide the power supply out of the main unit.

Note. When replacing the power supply, do not push the unit too far toward the front panel, as parts on the panel may be struck and damaged. Push the power supply in carefully, and stop when the screw-holes in the power supply line up with the screw-holes in the main unit.

e. Removal of R-f Unit (figs. 18 and 19). Observe the following procedure in removing the r-f unit from the receiver:

(1) Remove the TUNING, BAND SELECTOR, and ANTENNA TRIMMER controls from the front panel (fig. 18). Refer to paragraph 102*c* for instructions on removing the BAND SELECTOR control.

(2) Remove the four front-panel screws which hold the r-f unit in place (fig. 18). Remove the two mounting screws at the rear of the r-f unit (fig. 16).

(3) Disengage the interconnecting cable assembly, W302, from the r-f unit (fig. 16).

(4) Free the coax cable from the r-f unit, drawing it down through the opening in the main unit.

(5) Slide the r-f unit completely out of the main unit (see fig. 19).

Note. When replacing the r-f unit, be sure to aline the TUNING and BAND SELECTOR shafts with the holes in the front panel. Also be sure that the turret positions coincide with the front panel band designations.

f. Preliminary Disassembly of R-f Unit (fig. 20). The r-f unit contains the first hfo (high frequency oscillator) section, first mixer section, and the second mixer section. All band selection and tuning of the received signal is done in the r-f unit by means of a gear assembly. The r-f unit is shielded on all sides by dust covers, but most adjustments which apply to the r-f unit can be made through small holes in

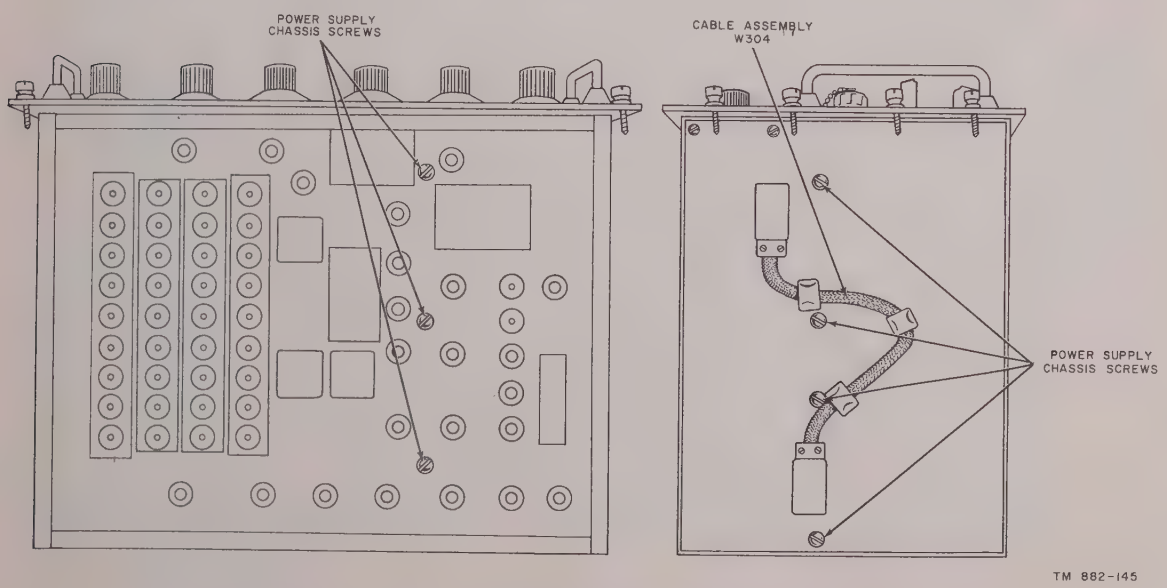

Figure 17. Receiver bottom and right side views, showing power supply chassis screws.

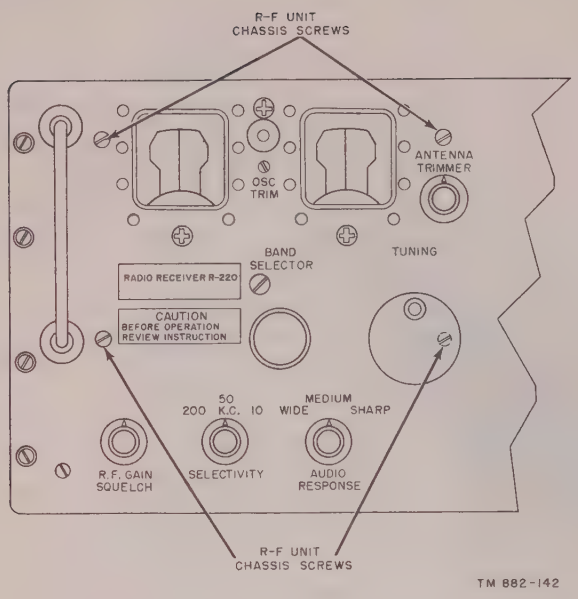

Figure 18. Receiver front panel, showing r-f chassis screws.

the covers of the several sections without removing the covers. For changing tubes and making minor replacements, it is also possible to remove one cover in order to secure access to a given section without disturbing the covers of the other sections. Dust covers should be removed from the r-f unit in the following order:

(1) Remove the screws which fasten covers over the first mixer section.

(2) Remove the screws which fasten covers over the second mixer section.

(3) Remove the screws which fasten the first hfo section cover to the rear cover.

(4) Remove the remaining screws on the first hfo section cover. (See *Caution*, below.)

Caution: Do not make any adjustments on the first hfo unless necessary equipment is available for retuning the unit.

(5) Detailed instructions for further disassembly of the r-f unit will be found in chapter 6.

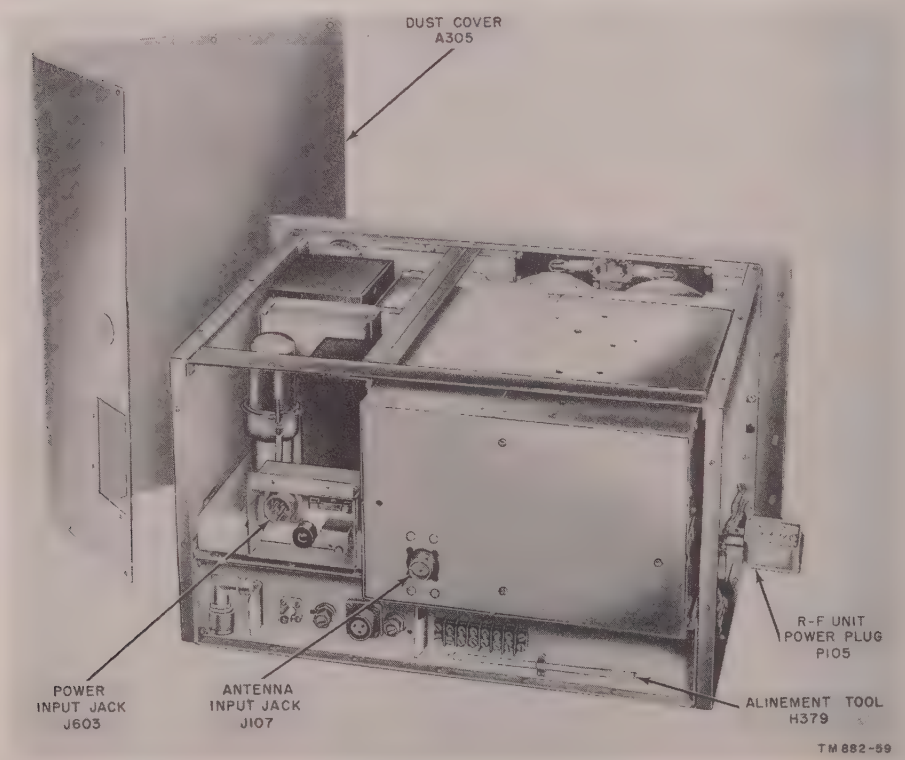

Figure 19. Radio Receiver R–220/URR removed from Receiver Case CY–956/URR.

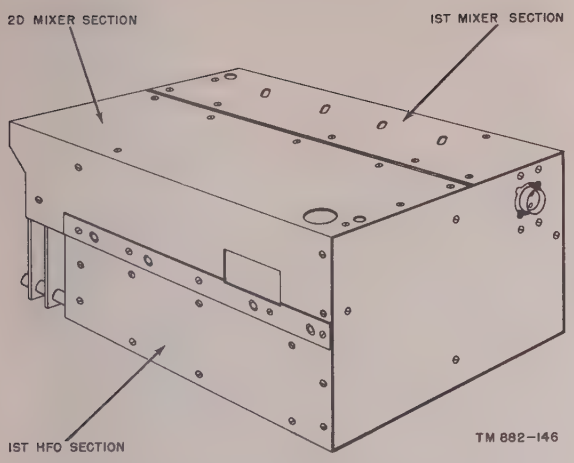

Figure 20. R-f unit, over-all view showing dust cover removal.

g. Preliminary Disassembly of Main Unit (fig. 21). In order to check tubes and make other preliminary checks on the main unit, no further disassembly is required other than taking off the base plate and removing the r-f unit and power supply as outlined in the preceding subparagraphs. The front panel, which contains the operating controls, is a part of the main unit. No tuning of the signal is performed in the main unit, the signal entering it from the r-f unit being always the 1.75-mc i-f. The main unit contains all signal circuits which follow the second mixer stage.

18. Checking New Equipment
(figs. 22, 23, and 24)

Note. Instructions for checking Antenna Assembly AS–574/URR will be found in TM 11–5016 (when published). Check the equipment for possible damage incurred during the shipment.

a. Remove all the packing material from the crates or cartons containing Radio Receiving Set AN/URR–29 (par. 16).

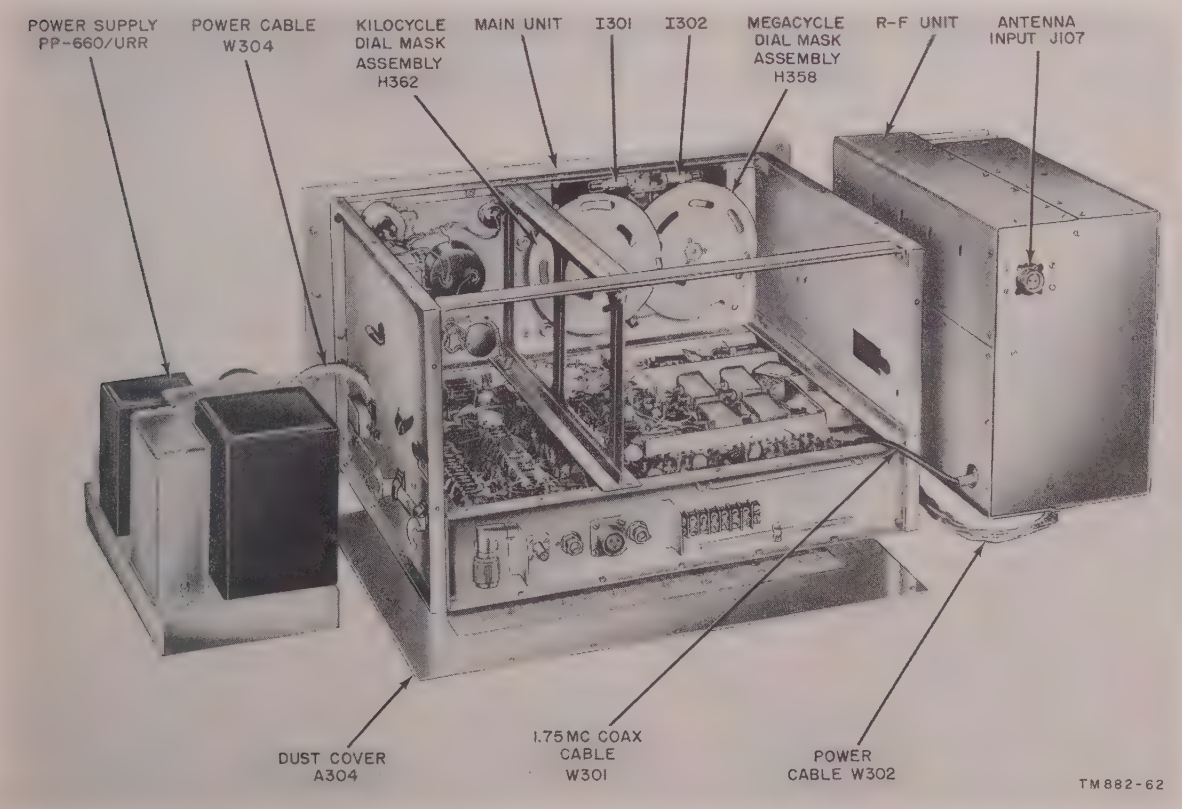

Figure 21. Radio Receiver R–220/URR, rear view, with r-f unit and power supply removed from main unit.

b. Release the latches from Receiver Case CY–956/URR and remove the cover from the case (par. 8).

c. Inspect all front panel and rear apron controls and jacks for looseness, binding, and damage (fig. 26). Check fuses at rear of power supply (fig. 5).

d. Remove the receiver from the case and inspect the two cable connectors and their respective plugs and connector receptacles for contact, looseness, cracks or other damage (figs. 14 and 15).

e. Check and inspect the wrenches and alinement tool which are fastened to the outside of the main unit (figs. 14 and 19).

f. Remove the r-f unit and power supply unit from the main unit base (fig. 21). Remove dust covers from the r-f unit (par. 17*f*) and check r-f and power cables between units and sections for contact, looseness, cracks, or other damage. Check antenna adapter on power supply chassis (fig. 5).

g. Inspect the units for damaged resistors, broken leads, bent parts, etc.

h. Make sure all crystals are firmly seated in their respective sockets. There are nine crystals used in the receiver, the frequency of each crystal is lettered on the crystal holder as well as on the crystal cover for Y102 through Y108 and the chassis for Y101. (See figure 91 for location of Y101; figure 95 for location of Y102, Y103, Y104, Y105, Y106, Y107, and Y108; figure 30 for location of Y301.)

i. Make sure all tubes are firmly seated in their respective sockets (figs. 22, 23, and 24).

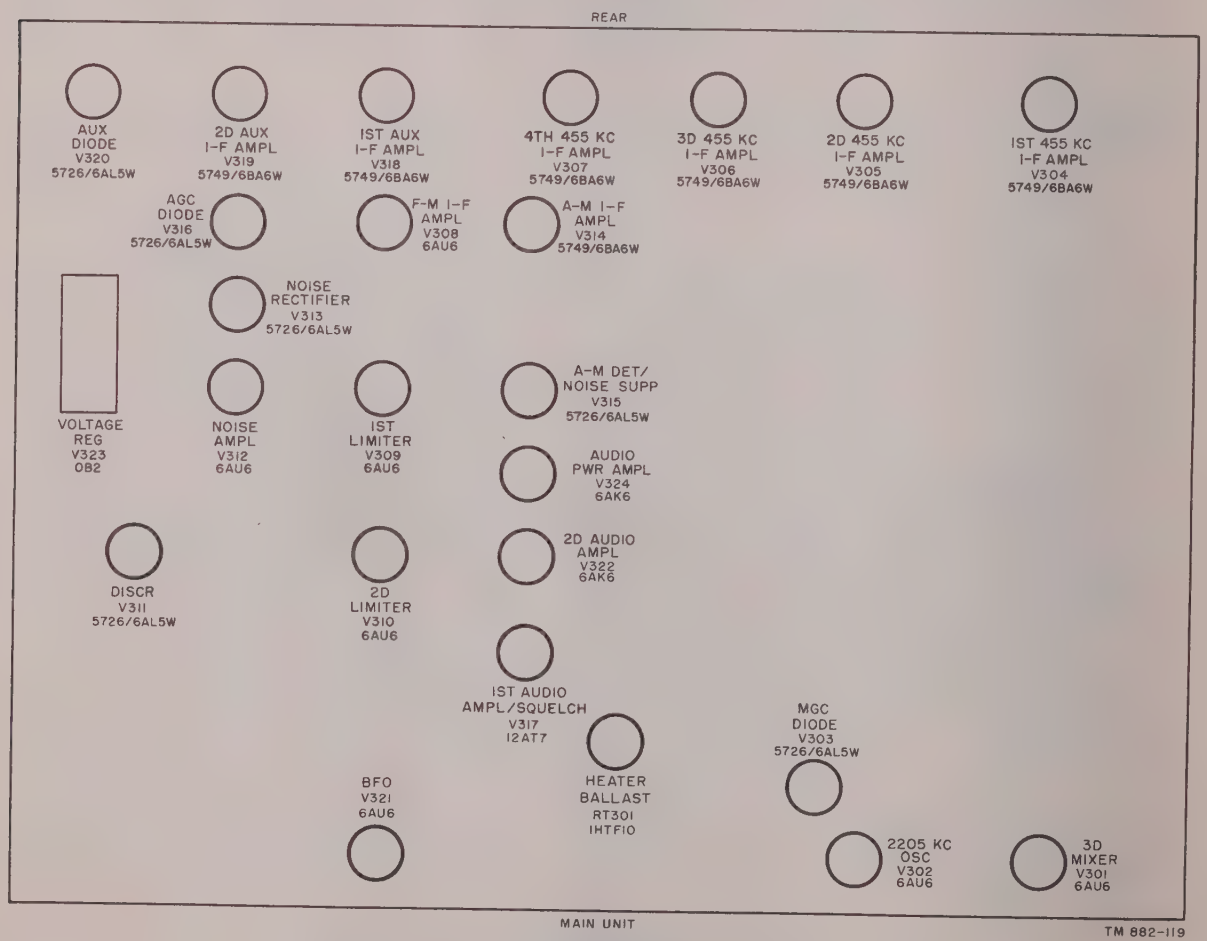
REAR
AUX DIODE V320 5726/6AL5W
2D AUX I-F AMPL V319 5749/6BA6W
IST AUX I-F AMPL V318 5749/6BA6W
4TH 455 KC I-F AMPL V307 5749/6BA6W
3D 455 KC I-F AMPL V306 5749/6BA6W
2D 455 KC I-F AMPL V305 5749/6BA6W
IST 455 KC I-F AMPL V304 5749/6BA6W
AGC DIODE V316 5726/6AL5W
F-M I-F AMPL V308 6AU6
A-M I-F AMPL V314 5749/6BA6W
NOISE RECTIFIER V313 5726/6AL5W
VOLTAGE REG V323 0B2
NOISE AMPL V312 6AU6
IST LIMITER V309 6AU6
A-M DET/ NOISE SUPP V315 5726/6AL5W
AUDIO PWR AMPL V324 6AK6
2D AUDIO AMPL V322 6AK6
DISCR V311 5726/6AL5W
2D LIMITER V310 6AU6
IST AUDIO AMPL/SQUELCH V317 12AT7
MGC DIODE V303 5726/6AL5W
HEATER BALLAST RT301 1HTF10
BFO V321 6AU6
2205 KC OSC V302 6AU6
3D MIXER V301 6AU6
MAIN UNIT
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Figure 22. Tube location, main unit.

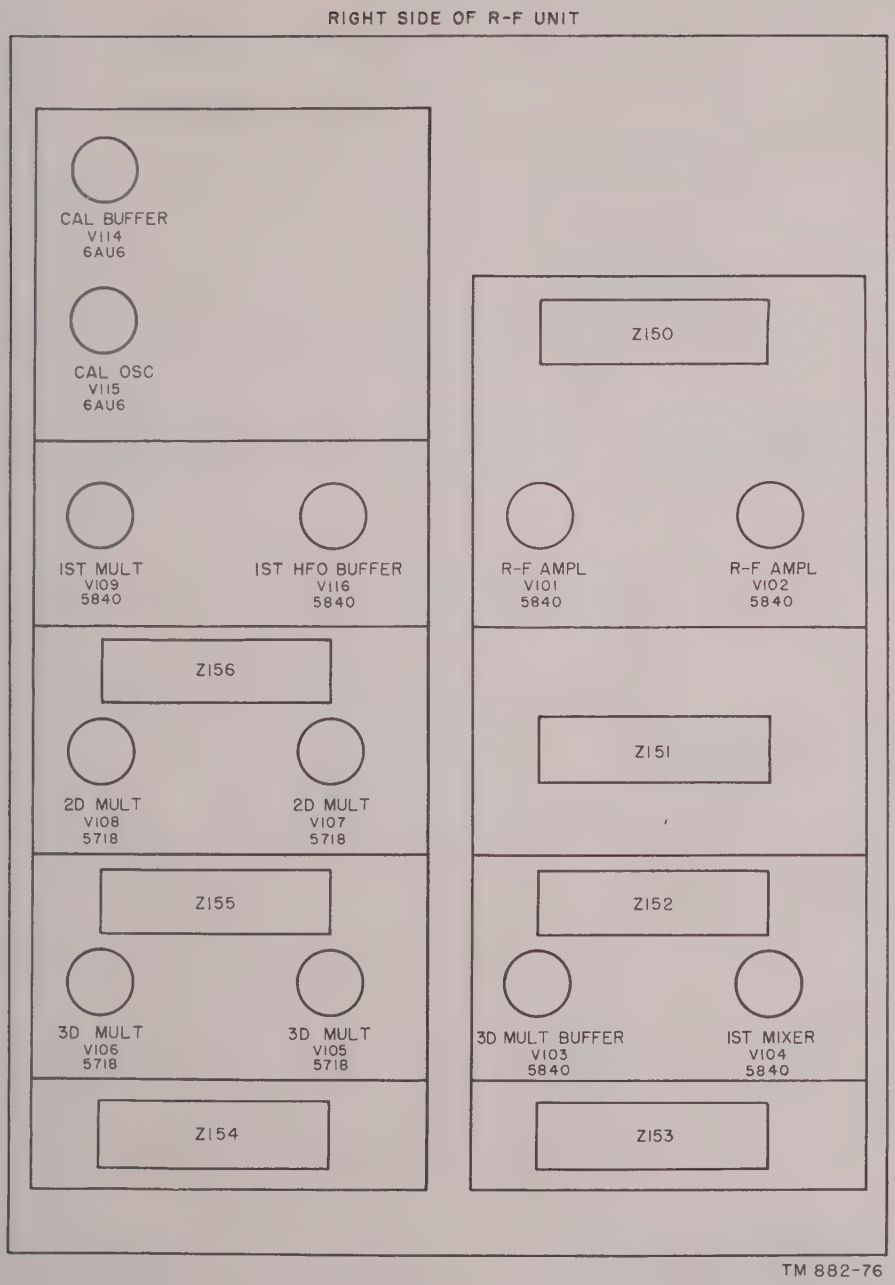

Figure 23. Tube location, right side of r-f unit.

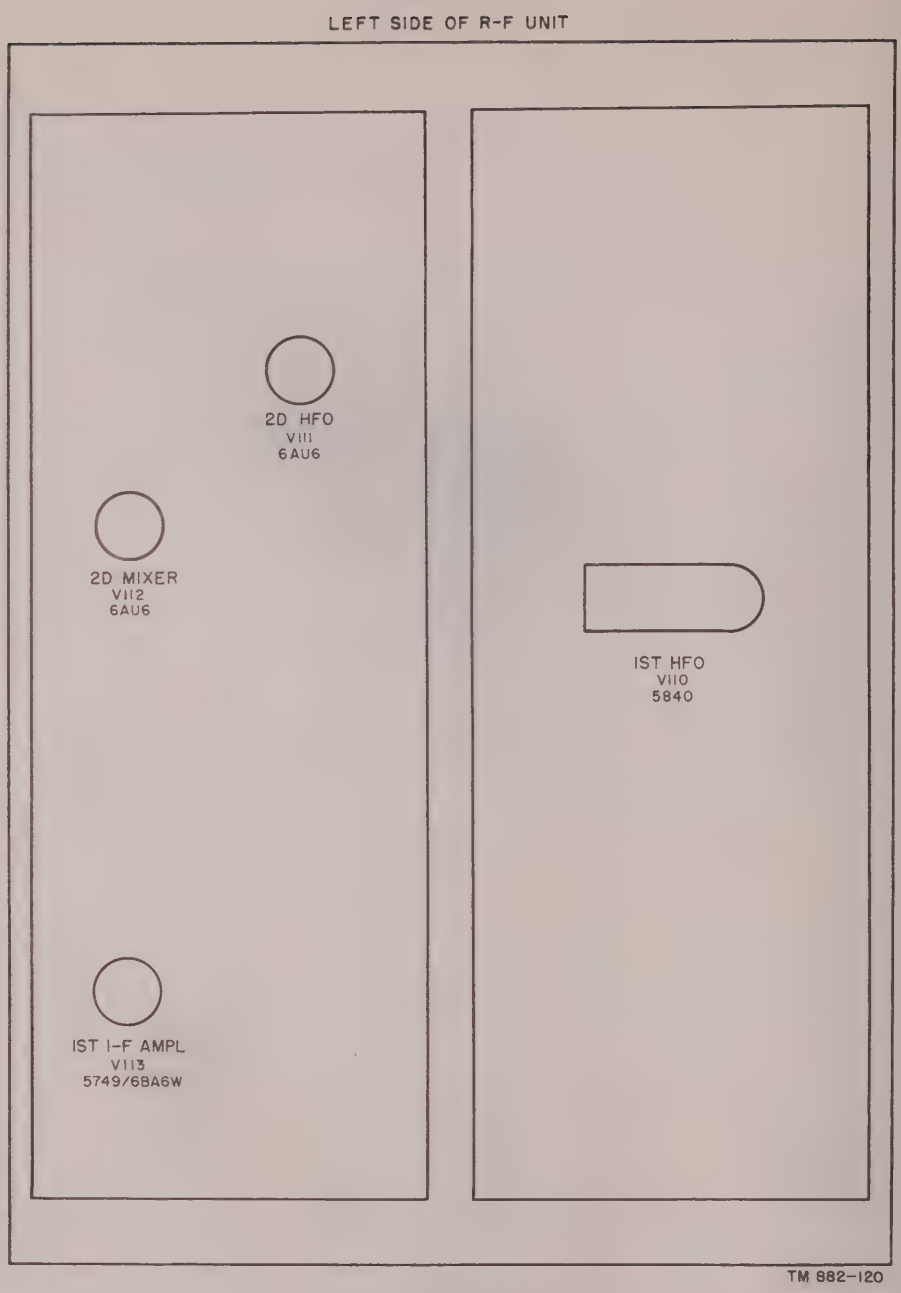

Figure 24. Tube location, left side of r-f unit.

19. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 16 for uncrating and unpacking the equipment; follow the instructions in paragraphs 17 and 18 for disassembling (preliminary) and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the changes in this instruction book, preferably on the schematic diagram.

c. Check the operating controls for ease of

rotation. If lubrication is required, refer to the lubrication instructions in chapter 6, section II.

20. Connections

(fig. 25)

After checking the seating of tubes and crystals, reassemble the receiver, making sure all sections and units are properly interconnected (par. 103).

a. Connect headset Navy type CW–49507 to Cord CD–307–A.

b. Connect Cord CD–307–A to AUDIO OUTPUT jack J305 (or J306).

c. Connect cable assembly CG–718/U or CG–1079/U to Antenna Assembly AS–574/URR.

(1) If cable assembly CG–718/U is used, make connection to antenna input jack J107 through antenna adapter E101.

(2) If cable assembly CG–1079/U is used, make connection directly to antenna input jack J107.

d. Make connections to terminal board TB308 (if used).

(1) Use terminals 1 and 2 for 600-ohm speaker output.

(2) Use terminals 3 and 6 for 600-ohm balanced line output.

e. Make connections to aux. i-f output J302 and to aux. diode output J301 (if used).

f. Connect one end of Power Cable Assembly CX–2639/U to power input jack J603.

g. Connect the other end of Power Cable Assembly CX–2639/U to the external power source.

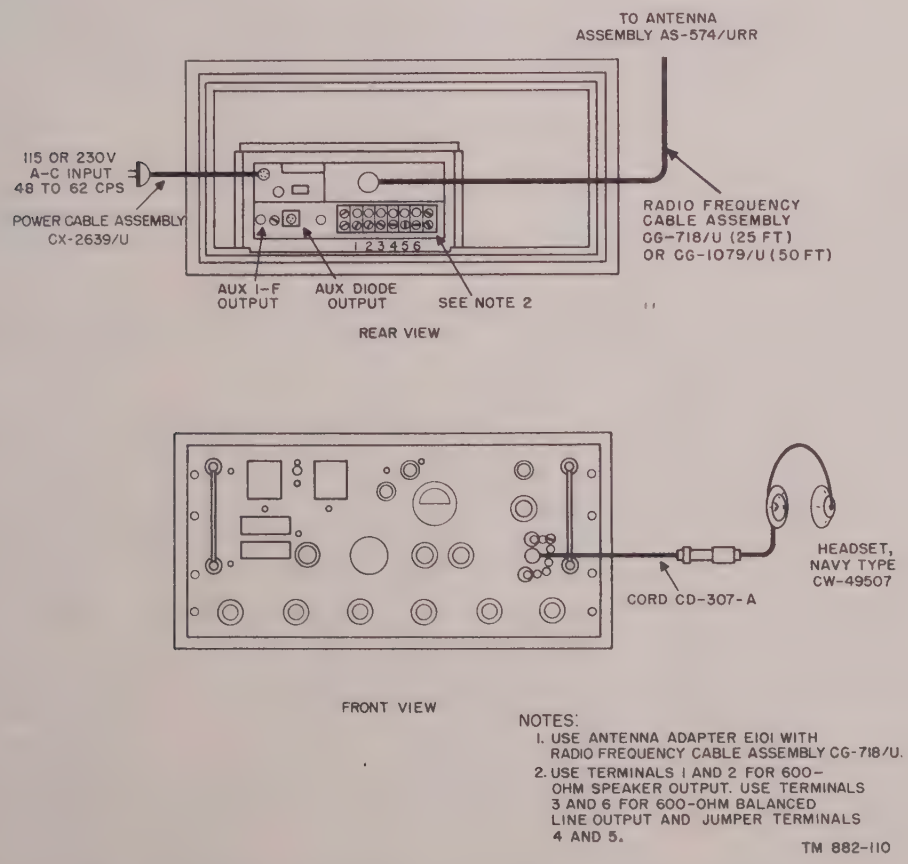
TO ANTENNA ASSEMBLY AS-574/URR
115 OR 230V A-C INPUT 48 TO 62 CPS
POWER CABLE ASSEMBLY CX-2639/U
RADIO FREQUENCY CABLE ASSEMBLY CG-718/U (25 FT) OR CG-1079/U (50 FT)
1 2 3 4 5 6
AUX I-F OUTPUT
AUX DIODE OUTPUT
SEE NOTE 2
REAR VIEW
HEADSET, NAVY TYPE CW-49507
CORD CD-307-A
FRONT VIEW
NOTES:
1. USE ANTENNA ADAPTER E101 WITH RADIO FREQUENCY CABLE ASSEMBLY CG-718/U.
2. USE TERMINALS 1 AND 2 FOR 600-OHM SPEAKER OUTPUT. USE TERMINALS 3 AND 6 FOR 600-OHM BALANCED LINE OUTPUT AND JUMPER TERMINALS 4 AND 5.
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Figure 25. External connections of Radio Receiving Set AN/URR–29.

CHAPTER 3

OPERATION

Section I. CONTROLS AND INSTRUMENTS

21. General

Haphazard operation or improper setting of the controls can cause damage to electrical equipment. For this reason, it is important to know the function of every control. The actual operation of the equipment is discussed in the next section of this instruction book.

22. Controls and Their Use
(figs. 4, 19, and 26)

The controls for Radio Receiver R–220/URR are located on the front panel and the rear apron of the main unit. The controls for Power Supply PP–660/URR are located at the rear of the power supply chassis. The following charts list the controls for the radio receiver and power supply and indicate what they do.

a. Radio Receiver R–220/URR, Front Panel Controls (fig. 26).

Control	Function
TUNING (C102, C108, C109, C117, C121, C128, C136, C152, and C155)	Controls the operating frequency of the receiver. Tunes to the desired frequency within the operating band. The vernier dial is calibrated in kc and the main dial is calibrated in mc.
BAND SELECTOR (Turrets Z150 through Z156, and switches S101 and S102)	Selects the operating band of the receiver. Used to select any one of seven bands. Dial is calibrated in mc.
OSC. TRIM (C154, C158)	Removing the single screw cap exposes two slotted shafts. 1. Left shaft marked E controls trimmer capacitor C158. It is used to adjust the dial calibration of the even bands. 2. Right shaft marked O controls trimmer capacitor C154. It is used to adjust the dial calibration of the odd bands.
CALIBRATE switch (S308)	In the ON position, S308 is closed, supplying B+ to the plate and screen grid of the calibrator oscillator and calibrator buffer. This permits dial calibration for any of the seven bands.
DIAL LIGHT control (S307, R392)	Clockwise rotation turns on the dial lamps over the megacycle and kilocycle dials. Further clockwise rotation increases the degree of illumination.
ANTENNA TRIMMER (C101)	Used to compensate for mismatching of the antenna to the receiver.

Control	Function
METER switch (S305)	Used to switch microammeter M301 to any one of five positions, as follows: 1. CARRIER. Measures strength of carrier signal. 2. OUTPUT LOW. Measures strength of audio signal. Used for weak signals. 3. OUTPUT HIGH. Measures strength of audio signal. Used for strong signals. 4. LIMITER. Measures first limiter grid current. 5. DISC. Indicates balance of discriminator.
AUDIO GAIN 1 (R383)	Controls level of audio signal output at TB308, J305, and J306.
AUDIO GAIN 2 (R423)	Controls level of audio signal at the 600-ohm speaker output on TB308 and at J305 and J306 without disturbing the audio level of the 600-ohm balanced line output on TB308.
AUDIO OUTPUT (J305, J306)	Removing the two screw caps exposes the two 600-ohm output jacks. Plug speaker or headset into either of these jacks. Two speakers or headsets may be used at the same time.
SELECTIVITY switch (S301)	Two-section, three-position rotary switch with pointer knob, used to select the bandwidth of the 455-kc i-f signal. 200 K.C. In this position, all frequencies between 355 kc and 555 kc are passed. 50 K.C. In this position, all frequencies between 430 kc and 480 kc are passed. 10 K.C. In this position, all frequencies between 450 kc and 460 kc are passed.
AUDIO RESPONSE (S304)	Two-section, three-position rotary switch with pointer knob, used to select the frequency response of the audio output of the receiver. 1. WIDE. Direct, or normal, response. 2. MEDIUM. Restricts audio response to no higher than 3,500 cps. 3. SHARP. Restricts audio response to between 400 and 1200 cps. Used for reception of c-w or mcw.
NOISE LIMITER (S302, R380)	Clockwise rotation closes S302, limiting the amount of noise present in the audio output. Further clockwise rotation increases the limiting action.
B.F. OSCILLATOR (S306, C409)	Switches bfo on and off; varies the frequency of the audio output, thus varying the pitch of c-w signals. OFF. With the pointer set at this position, the bfo is inoperative. O. With the pointer set at this position, the bfo is at zero beat. This position is used for calibration.
OPERATION (S303, S309, S310)	Used to select type of operation. Consists of a two-section, six-position, rotary switch (S303), ganged to two microswitches (S310 and S309). Positions are as follows: 1. OFF. S310 is opened and all circuits in the receiver are inoperative.

a. Radio Receiver R–220/URR, Front Panel Controls (contd)

Control	Function
	2. STANDBY. Closes S310, applying a-c to the power supply and to the oscillator heater element. All filament power applied. Regulated 105-volts d-c applied to the first hfo, V110, and to the discriminator meter center control, R420. No B+ applied to the remaining tubes. 3. MGC. Closes S309, applying operating B+ voltage for this and the following positions. Permits a-m reception in conjunction with mgc. 4. AGC. Permits a-m reception in conjunction with agc. 5. AM SQUELCH. Permits a-m reception in conjunction with agc and squelch. 6. FM SQUELCH. Permits f-m reception in conjunction with mgc and squelch.
R.F. GAIN–SQUELCH (R310A, R310B)	R.F. GAIN (R310B). Controls the amount of mgc when the OPERATION switch is in MGC position. SQUELCH (R310A). Controls the squelch threshold when the OPERATION switch is in the AM SQUELCH or FM SQUELCH position.

b. Radio Receiver R–220/URR, Rear Apron Controls (fig. 26).

Control	Function
Discriminator meter center control (R420)	Screw-driver adjustment used to position the meter pointer for reading the discriminator circuit balance.
Carrier meter center control (R429)	Screw-driver adjustment which adjusts the position of meter pointer for reading carrier level.
Aux. i-f output (J302)	Provides 455-kc output of 1 mv across 50 ohms.
Aux. diode output (J301)	Provides an output of 5v across 47,000 ohms.
Audio output (TB308)	Provides a balanced 600-ohm output of 100 mw across terminals 3 and 6 and a 600-ohm output of .5 watt across terminals 1 and 2.

c. Radio Receiver R–220/URR, R-f Unit Control (fig. 19).

Control	Function
Antenna input (J107)	Antenna terminal jack located on r-f chassis. For connection of antenna to receiver.

d. Power Supply PP–660/URR Controls (fig. 5).

Control	Function
230/115-volt switch (S601)	Line voltage selector switch. Located at rear of power supply chassis. Used to select either 115-v or 230-v primary circuit.
Fuse, 3 amp (F602)	Power line fuse in primary circuit of transformer T601. Provides protection from overloads.
Spare fuse holder (E603)	Spare fuseholder, located just above S601, used to hold spare 3-amp fuse.
Power input connector (J603)	Provides connection to 230-v or 115-v power source.

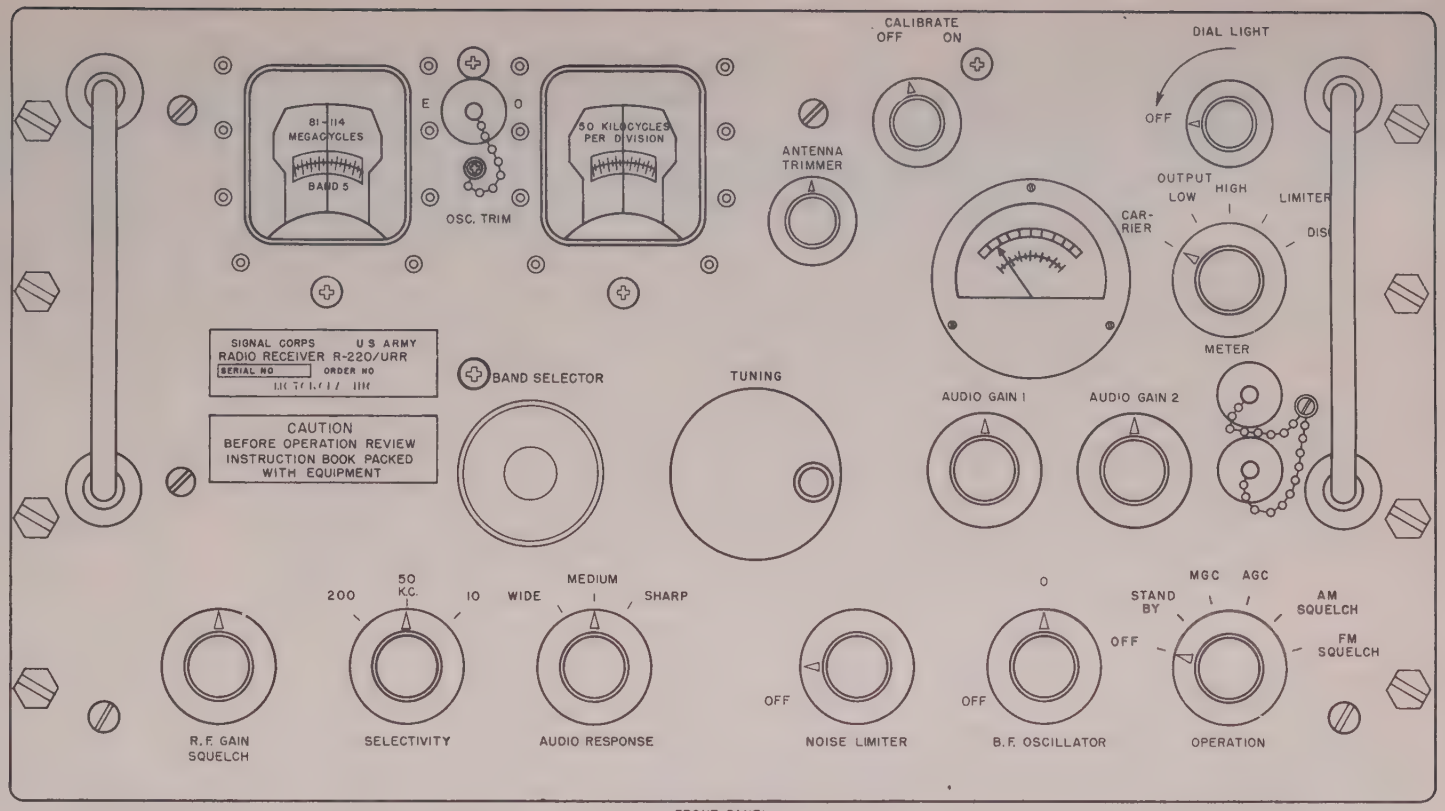

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Figure 26. Front panel and rear chassis controls.

Section II. OPERATION UNDER USUAL CONDITIONS

23. Starting Procedure

Perform the starting procedure given below for operating the receiver.

a. Rotate the OPERATION switch to the OFF position.

b. Connect the power line cord to a suitable source of power and set the 230/115-volt switch to the proper position.

(1) Set the 230/115-volt switch to the left for 230-volt operation.

(2) Set the 230/115-volt switch to the right for 115-volt operation.

c. Connect the antenna transmission line to the antenna input jack, J107, at the rear of the r-f unit.

d. Plug the low-impedance speaker or headphones (600 ohms) into one of the AUDIO OUTPUT jacks (J305, J306) on the front panel, or connect the speaker or headphones to terminals 1 and 2 of terminal board TB308 at the rear of the receiver.

e. Rotate the OPERATION switch to the STANDBY position. The STANDBY position affects the following circuits:

(1) All tube filaments are operative.

(2) Dial lamps are operative.

(3) First hfo plate and screen voltages are applied.

(4) Regulated 105-v d-c applied to discriminator meter center control (R420).

(5) Power is applied to the oscillator heater element.

(6) B+ removed from the plates and screen grids of all tubes except the first hfo and the rectifier.

f. Rotate the DIAL LIGHT control clockwise for sufficient illumination.

g. Rotate the BAND SELECTOR switch to the desired band, as indicated on the megacycle dial mask.

h. Rotate the TUNING control to the desired frequency, as indicated on the mc and kc dials.

i. Rotate the SELECTIVITY switch to the desired position, as follows:

(1) 200 K.C. For normal f-m reception.

(2) 50 K.C. For a-m voice or narrow-band f-m reception.

(3) 10 K.C. For c-w or mcw reception.

j. Turn the AUDIO RESPONSE switch to the WIDE position.

k. Turn the CALIBRATE switch to the OFF position.

l. Turn the METER switch to the CARRIER position.

m. Turn off the following controls:

(1) R.F. GAIN–SQUELCH. Extreme counterclockwise position.

(2) NOISE LIMITER.

(3) B.F. OSCILLATOR.

n. Rotate the OPERATION switch for the desired type of operation (see following paragraph).

24. Types of Operation

Operating procedure for the types of signals that may be received on Radio Receiving Set AN/URR–29 are listed in the succeeding subparagraphs in the following order: f-m, a-m, mcw, and c-w.

a. F-m Reception. To receive f-m signals, perform the following operations in the order given:

(1) Rotate the BAND SELECTOR control to the band desired.

(2) Rotate the SELECTIVITY switch to one of the following positions:

(a) 50 K.C. For narrow-band f-m reception.

(b) 200 K.C. For normal f-m reception.

(3) Set the METER switch to the CARRIER position.

(4) Rotate the OPERATION switch to the FM SQUELCH position.

(5) Turn the R.F. GAIN–SQUELCH control to the extreme clockwise position.

(6) Advance AUDIO GAIN 1 and AUDIO GAIN 2 controls clockwise to the approximate mid-point of rotation.

(7) Rotate the TUNING control to the desired frequency. Adjust the TUNING control until the meter indicates a maximum reading.

(8) Rotate the ANTENNA TRIMMER until the meter indicates a maximum reading. This adjustment compensates for any antenna mismatch.

(9) Readjust the TUNING control for maximum deflection on the meter. This adjustment tunes the receiver exactly to the incoming signal.

(10) Rotate the AUDIO RESPONSE switch to the WIDE position. If the signal is not clear or becomes unintelligible as a result of this operation, rotate the AUDIO RESPONSE switch to the MEDIUM position.

(11) Rotate the R.F. GAIN–SQUELCH control counterclockwise until the noise in the speaker or headphones disappears.

(12) Carefully rotate the R.F. GAIN–SQUELCH control clockwise to the point where the noise reappears. Rotate the R.F. GAIN–SQUELCH control counterclockwise just beyond the point where the noise disappears. When this adjustment is completed, the receiver will remain quiet during periods when no signal is being received.

b. A-m or Mcw Reception.

(1) Rotate the BAND SELECTOR switch to the desired band.

(2) Rotate the SELECTIVITY switch to the 50 K.C. position.

(3) Rotate the AUDIO RESPONSE switch to MEDIUM.

(4) Rotate the METER switch to the CARRIER position.

(5) Rotate the OPERATION switch to one of the following positions, according to the character of the received signal:

(a) MGC. for weak or distant signals. In this position, the R.F. GAIN–SQUELCH control operates the r-f gain only, the squelch circuit remaining inoperative.

(b) AGC. For strong signals. In this position, the R.F. GAIN–SQUELCH control is completely inoperative.

(c) AM SQUELCH. For strong signals, where tuning between signals is necessary, and when receiver noise and atmospherics are present. In this position, the R.F. GAIN–SQUELCH control operates the squelch threshold only, the r-f gain control remaining inoperative.

(6) Rotate the TUNING control to the desired frequency.

(7) Rotate the ANTENNA TRIMMER for maximum deflection on the meter.

(8) Readjust the TUNING control for maximum deflection on the meter.

(9) For a-m reception, proceed to subparagraph (10). For mcw reception, make the following adjustments:

(a) Rotate the SELECTIVITY switch to the 10 K.C. position.

(b) Rotate the AUDIO RESPONSE switch to the SHARP position.

(10) Adjust the R.F. GAIN–SQUELCH control according to the type of operation, as follows:

(a) If OPERATION switch is in the AM SQUELCH position, adjust the squelch threshold as described in subparagraph *a*(12) above. Then proceed to subparagraph *b*(11) below.

(b) If OPERATION switch is in the MGC position, rotate the R.F. GAIN–SQUELCH control until the signal is at the desired level.

(c) If OPERATION switch is in the AGC position, rotate the R.F. GAIN–SQUELCH control to the off position (extreme counterclockwise).

(11) Rotate the NOISE LIMITER control clockwise until the signal reaches maximum intelligibility.

c. C-w Reception.

(1) Rotate the BAND SELECTOR control to the desired band.

(2) Rotate the SELECTIVITY switch to the 50 K.C. position.

(3) Rotate the AUDIO RESPONSE switch to the MEDIUM position.

(4) Rotate the METER switch to the CARRIER position.

(5) Rotate the OPERATION switch to the MGC position.

(6) Rotate the TUNING control to the desired frequency.

(7) Adjust the ANTENNA TRIMMER to obtain maximum deflection on the meter.

(8) Readjust the TUNING control for maximum deflection on the meter.

(9) Rotate the SELECTIVITY switch to the 10 K.C. position to eliminate background noise and adjacent-signal interference. If this action tends to cut out the signal, readjust the TUNING control to again obtain the signal, watching for a maximum deflection of the meter rather than depending upon the audio level.

(10) Rotate the AUDIO RESPONSE switch to the SHARP position.

(11) Rotate the R.F. GAIN–SQUELCH control until the desired signal level is obtained.

(12) Rotate the B.F. OSCILLATOR control clockwise until an a-f beat note is obtained.

(13) Rotate the NOISE LIMITER control clockwise until the readability of the signal reaches a satisfactory level.

25. Standby Procedure

a. Rotate OPERATION switch to the STANDBY position.

b. Leave all other controls in the position they were in during reception. This will facilitate quick starting and operation the next time the receiver is used.

26. Stopping Procedure

a. Rotate OPERATION switch to OFF.

b. Remove headset or speaker, antenna transmission line, and power input cable.

c. Replace front cover.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

27. General

The operation of Radio Receiving Set AN/URR–29 may be difficult in regions where extreme cold, heat, humidity and moisture, or sand conditions prevail. In the following paragraphs, instructions are given on procedures for minimizing the effect of these unusual operating conditions.

28. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep the equipment warm and dry. If the set is not in a heated enclosure, construct an insulated box for it. Keep resistor heaters (if supplied) turned on, provided this does not overtax the supply line or battery. If this method is impractical, keep the electron tube filaments lighted constantly, unless this also overtaxes the supply line or battery.

c. Locate the equipment inside a heated enclosure where there is no danger of a cold draft striking the glass tubes when a door is opened. A sudden draft of cold air is often sufficient to shatter the glass envelope of a heated tube. If the enclosure is constructed so that this pre-

caution is impossible, place a blanket or some barrier between the source of the draft and the equipment.

d. Wear a knitted woolen cap over the earphones when operating in the open air with headsets that do not have rubber earpieces. Frequently, when headsets without rubber earpieces are worn, the edges of the ears may freeze without the operator being conscious of this condition. Never flex rubber earcaps, since this action may render them useless. If water gets into the receivers, or if moisture condenses within them, it may freeze and impede the action of the diaphragm. When this happens, unscrew the bakelite cap and remove the ice and moisture from the receiver.

e. When equipment which has been exposed to the cold is brought into a warm room, it will start to sweat and will continue to do so until it reaches room temperature. This condition also arises when equipment warms up during the day after exposure during a cold night. When the equipment has reached room temperature, dry it thoroughly.

29. Operation in Tropical Climates

When operated in tropical climates, radio equipment may be installed in tents, huts, or, when necessary, in underground dugouts. When equipment is installed below ground or when it is set up in swampy areas, moisture conditions are more acute than is normal in the tropics. Ventilation is usually very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the ambient air. To minimize these conditions, place lighted electric lamps under the equipment.

30. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem which arises with equipment operation in desert areas is the large amount of sand or dust and dirt which enters the moving parts of the radio set such as the dial assembly and gear train. The ideal preventive is to house the unit in a dustproof shelter. Since, however, such a building is seldom available and would require air conditioning, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and secure the side walls of tents with sand to prevent their flapping in the wind.

c. Never tie power cords, signal cords, or other wiring connections to the inside or outside of tents. Desert areas are subject to sudden wind squalls which may jerk the connections loose or break the lines.

d. Take care to keep the equipment as free from dust as possible. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit, which will damage the equipment.

Section IV. PRESETTING AND INITIAL ADJUSTMENT

31. Presetting Radio Receiver R–220/URR

a. General. Presetting the receiver is concerned principally with adjusting the OSC. TRIM slotted shafts on the front panel to calibrate the dial correctly. Alinement of one spot in any particular sector of the band being used is sufficient. Original tracking of the first hfo was performed with both OSC. TRIM shaft slots in a vertical position. For greatest overall accuracy, make sure these slots remain in a vertical position. However, for correction of a particular frequency, a slight adjustment of one of the shafts may be necessary. In this case, follow the Dial Calibration Procedure given in the following subparagraph.

b. Dial Calibration Procedure.

(1) Adjust the receiver controls for c-w reception (par. 24*c*).

(2) Rotate the BAND SELECTOR to the desired band.

(3) Rotate the TUNING control so that the dial reads the multiple of 5 mc nearest the desired frequency. (For example, if the desired frequency is 100.3 mc, tune the receiver to 100 mc.)

(4) Turn the CALIBRATE switch clockwise to ON.

(5) Rotate the B.F. OSCILLATOR control to the 0 position (dial pointer straight up).

(6) Unscrew the cap which covers the OSC. TRIM shafts. Adjust the proper shaft until the calibrator signal is at zero beat with the bfo signal. Use the shaft on the left, marked E, to trim the even bands (2, 4, and 6). Use the shaft on the right, marked O, for the odd bands (1, 3, 5, and 7).

32. Initial Adjustment and Antijamming

a. Initial Adjustment. Initial adjustment of the receiver is performed with the discriminator meter centering control, which is located on the rear apron of the main chassis. This adjustment must be made so that when the METER switch is rotated to the DISC position, the meter needle will be properly centered on the DISC. CENTER scale. Use a screwdriver in making this adjustment.

b. Discriminator Meter Balance Adjustment.

(1) Adjust the receiver controls for f-m reception (par. 24*a*).

(2) Rotate the METER switch to the DISC position.

(3) Rotate the TUNING control to a point where no signal is being received.

(4) Adjust the discriminator meter center control at the rear of the chassis until the meter needle points to the 25-ua (microampere) position on the DISC. CENTER scale. This position is indicated by a long vertical line on the meter scale.

c. Antijamming. When an operator recognizes that his receiver is being jammed, he will promptly inform his immediate superior officer of this fact. Under no conditions will he cease operating. In order to provide maximum intelligibility of jammed signals, he will adhere to the operational procedures as indicated for each type of operation.

(1) When the operator is receiving a-m and the jamming signal is c-w, pulse, or some other type of sharp noise signal, he will follow the procedure indicated below, if possible, until some degree of read-through is established.

(a) Turn the TUNING control very slightly through a degree or two on either side of the desired frequency. It may be possible to read through the interfering signal somewhat.

(b) Turn on the NOISE LIMITER. Noise peaks may be sufficiently reduced to afford some measure of read-through. Turn NOISE LIMITER to OFF if no improvement results.

(c) Adjust ANTENNA TRIMMER for best reception.

(d) Set the SELECTIVITY control to the position providing the best receiving conditions. Slight tuning as described in step *(a)* may be necessary.

(e) Turn OPERATION switch to MGC and turn down the R.F. GAIN–SQUELCH control until signals clear up. Use the R.F. GAIN–SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 controls while tuning slightly as in step *(a)*.

(f) Change the direction, length, and height of the antenna, if this is permissible.

(g) Request a change in frequency and call sign if the foregoing steps do not provide necessary communication.

(h) If jamming action is so thorough and complete that communication is impossible, report this fact to your immediate superior and use some alternate means of getting the message through. Continue to operate unless specifically instructed to do otherwise. The enemy may not realize his jamming success and may move to another frequency.

(2) When the operator is receiving a-m and the jamming signal is f-m, bagpipes, or a-m, he will follow the pro-

cedure indicated below, if possible, until read-through is established.

(a) Turn the TUNING control very slightly through a degree or two on either side of the desired frequency. It may be possible to read through the interfering signal somewhat.

(b) Adjust ANTENNA TRIMMER for best reception.

(c) Set the SELECTIVITY control to the position providing the best receiving conditions. Slight tuning as described in step *(a)* may be necessary.

(d) Turn OPERATION switch to MGC and turn down the R.F. GAIN–SQUELCH control until signals clear up. Use the R.F. GAIN–SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 controls while slightly tuning as in step *(a)*.

(e) Change the direction, length, and height of the antenna, if this is permissible.

(f) Request a change in frequency and call sign if the foregoing steps do not provide necessary communication.

(g) If jamming action is so thorough and complete that communication is impossible, report this fact to your immediate superior and use some alternate means of getting the message through. Continue to operate unless specifically instructed to do otherwise. The enemy may not realize his jamming success and may move to another frequency.

(3) When the operator is receiving c-w and the jamming signal is c-w or any other type of interference, he will follow the procedure in the order indicated below, if possible, until a degree of read-through is established.

(a) Turn the TUNING control very slightly through a degree or two on either side of the desired signal frequency. It may be possible to read through the interfering signal somewhat.

(b) Turn on the B.F. OSCILLATOR and vary it until a separate audio pitch for the interfering and desired signal results, if possible.

(c) Adjust ANTENNA TRIMMER for best reception.

(d) Set the SELECTIVITY control to the position providing the best receiving conditions. Slight tuning as described in step *(a)* may be necessary.

(e) Turn OPERATION switch to MGC and turn down the R.F. GAIN–SQUELCH control until signals clear up. Use the R.F. GAIN–SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 controls while slightly tuning as in step *(a)*.

(f) Change the direction, length, and height of the antenna if this is permissible.

(g) Request a change in frequency and call sign if the foregoing steps do not provide necessary communication.

(h) If jamming action is so thorough and complete that communication is impossible, report this fact to your immediate superior and use some alternate means of getting the message through. Continue to operate unless specifically instructed to do otherwise. The enemy may not realize his jamming success and may move to another frequency.

(4) When the operator is receiving f-m and any type of jamming interference occurs, he will follow the procedure indicated below, if possible, until some degree of read-through is established.

(a) Turn OPERATION switch to FM SQUELCH.

(b) Set the SELECTIVITY control to 200 K.C.

(c) Turn the TUNING control very slightly through a degree or two on either side of the desired signal frequency. It may be possible to read through the interfering signal somewhat.

(d) Adjust the ANTENNA TRIMMER for best reception; the desired signal may come through satisfactorily.

(e) If interference consists of noise, pulses, c-w, etc., turn on the NOISE LIMITER. If this action does not aid in read-through, turn it to OFF.

(f) Change the direction, length, and height of the antenna if this is permissible.

(g) Request a change in frequency and call sign if the foregoing steps do not provide necessary communication.

(h) If jamming action is so thorough and complete that communication is impossible, report this fact to your immediate superior and use some alternate means of getting the message through. Continue to operate unless specifically instructed to do otherwise. The enemy may not realize his jamming success and may move to another frequency.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

33. General

This chapter outlines the specific duties and responsibilities of organizational maintenance personnel. The two phases of organizational maintenance are the prevention of breakdown in the equipment and the repair of minor troubles that arise in spite of all precautions. Preventive measures include periodic cleaning and weatherproofing, as well as visual inspection of the electrical and mechanical characteristics of the components. Systematic recording and studying of performance characteristics are also important in the prevention of trouble. The general preventive maintenance techniques are those that can be performed with a minimum of equipment and effort. More extensive trouble-shooting and repair procedures are given in chapter 6.

34. Tools and Materials

Tools and test equipment issued at organizational level aid in the repairing of Radio Receiving Set AN/URR–29. The tools and materials contained in Tool Equipment TE–41 will be required for the organizational maintenance procedures discussed in paragraphs 43 and 44. Electron Tube Test Set TV–7/U, available at organizational maintenance levels, will indicate the most common forms of tube failure: open filaments, low emission, shorted elements, etc. However, to obtain a more positive check, substitute a new tube of the same type and note the operation of the equipment. Multimeter TS–297/U (1,000 ohms per volt) will satisfactorily check cords, cables, and plug-in items.

35. Special Tools Supplied

The special tools discussed in this paragraph are supplied with Radio Receiving Set AN/URR–29. These tools are required in addition to the tools supplied with Tool Equipment TE-41 for organizational maintenance.

a. Slotted Alinement Tool. An alinement tool, suitable for high frequency adjustments, is necessary for tuning all variable inductors and all screw-type shaft variable capacitors. The alinement tool is held to the rear of the main unit chassis by a clip (fig. 26).

b. Offset End Wrench. The offset end wrench, used for removing the shaft water seals on the front panel, is located on the left side of the main unit (fig. 14).

c. Spanner Wrench. The spanner wrench, used in conjunction with the offset end wrench for shaft water seal removal, is also located on the left side of the main unit (fig. 14).

Section II. PREVENTIVE MAINTENANCE SERVICES

36. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment to maintain good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring.

37. General Preventive Maintenance Techniques

a. Use #0000 sandpaper to remove corrosion. Never use steel wool.

b. Use a clean, dry lint-free cloth or a dry brush for cleaning. If necessary, moisten the cloth or brush with cleaning compound (Stock number 6G236.5) ; then wipe the parts dry with a cloth.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 psi (pounds per square inch) to remove dust from inaccessible places; be careful however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178, Preventive Maintenance Guide for Radio Communication Equipment.

38. Use of Preventive Maintenance Forms (figs. 27 and 28)

a. The information in paragraph 39 is presented as a guide to the individual making an inspection of equipment in accordance with instructions on DA Forms 11–238 and 11–239. The decision as to which items on the forms are applicable to this equipment is a tactical decision to be made by the communications officer/chief or his designated representative in the case of first echelon maintenance, and, in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 27 and 28 are partially or totally applicable to Radio Receiving Set AN/URR–29. References in the ITEM block refer to paragraphs in the text which contain additional maintenance information.

39. Performing Preventive Maintenance

a. Performing Exterior Preventive Maintenance.

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

(1) Check for completeness and satisfactory condition of the radio set. The components of the radio set are listed in paragraph 6 and are illustrated in figure 1.

(2) Check suitability of location and installation for normal operation (pars. 15 and 23).

(3) Clean dirt and moisture from antenna, headsets, jacks, plugs, and panels of the components.

(4) Inspect the seating of readily accessible plug-in items such as tubes, lamps, crystals, fuses, and connectors (figs. 22, 23, 24, and par. 18).

(5) Inspect all controls for binding, scraping, excessive looseness, worn or chipped gears, misalinement, and positive action (par. 22).

(6) Check for normal operation (ch. 3).

(7) Clean and tighten the panel mountings of the receiver and the exterior of components, cases, racks, mounts, shockmounts, antenna mounts, and coaxial transmission lines.

(8) Inspect cases, mounting, antenna, and exposed metal surfaces for rust, corrosion, and moisture.

(9) Inspect cords, cables, wires, and shockmounts for cuts, breaks, fraying, deterioration, kinks, and strain (fig. 25).

(10) Inspect antenna for eccentricities, corrosion, loose fit, and damaged insulators (par. 18).

(11) Inspect for looseness of accessible items such as switches, knobs, jacks, connectors, transformers, relays, plug-in capacitors, and pilot light assemblies.

(12) Clean name plate, dial, and meter window.

(13) Inspect meter for damaged glass.

(14) Inspect shelters and covers for adequacy of weatherproofing.

(15) Check antenna guy ropes for proper tension.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
RADIO RECEIVING SET AN/URR-29	

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 39 a (1)							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 39 a (2)							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR 39 a (3)							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 39 a (4)							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 39 a (5)							
6	CHECK FOR NORMAL OPERATION. PAR. 39 a (6)							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 39 a (7)		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 39 a (8)		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 39 a (12)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 39 a (9)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 39 a (13)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS. PAR. 39 a (10)		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING. PAR. 39 a (14)	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION. PAR. 39 a (15)	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 39 a (11)		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 39 b (12)

DA FORM 1 MAY 51 11-238 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

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Figure 27. DA Form 11-238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: RADIO RECEIVING SET AN/URR-29

EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories*). PAR. 39 a (1)	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 39 a (2)	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 39 a (3)	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 39 a (4)	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 39 a (5)	
6	CHECK FOR NORMAL OPERATION. PAR. 39 a (6)	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 39 a (7)	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 39 a (8)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 39 a (9)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS. PAR. 39 a (10)	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 39 a (11)	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 39 a (12)	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 39 a (13)	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING. PAR. 39 a (14)	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION. PAR. 39 a (15)	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	
19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS: INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES. PAR. 39 b (1)	
20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 39 b (2)	
22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.	
23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 39 b (3)	
24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 39 b (4)	
25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 39 b (5)	
26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 39 b (6)	
27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.	
28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 39 b (7)	
30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 39 b (8)	
32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 39 b (9)	
33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS. PAR. 39 b (10)	
37	MOISTURE AND FUNGIPROOF. PAR. 39 b (11)	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 39 b (12)	

DA FORM 1 MAY 51 11-239 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE. 16—04382-1

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Figure 28. DA Form 11–239.

b. Performing Interior Preventive Maintenance.

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.

(1) Inspect electron tubes for loose envelopes, and cracked sockets; clean dust and dirt carefully; check emission of tubes.

(2) Inspect fixed capacitors for leaks, bulges, and discoloration.

(3) Inspect variable capacitors for dirt, moisture, misalinement of plates, and loose mountings.

(4) Inspect resistors, bushings, and insulators for cracks, chipping, blistering, discoloration, and moisture.

(5) Inspect terminals of large fixed capacitors and resistors for corrosion, dirt, and loose contacts.

(6) Clean and tighten switches, terminal blocks, and interior of chassis and cabinet.

(7) Lubricate equipment in accordance with applicable Department of the Army lubrication order (ch. 2, sect. III).

(8) Clean and tighten connections and mountings of transformers, chokes, and potentiometers.

(9) Inspect transformers, chokes, and potentiometers for overheating and oil leakage.

(10) Inspect for leaking gaskets and worn or loose parts.

(11) Check adequacy of moisture and fungiproof treatment (par. 41).

(12) If deficiencies noted are not corrected during inspection, indicate what action was taken to correct the deficiencies.

Section III. LUBRICATION AND WEATHERPROOFING

40. Lubrication

The mechanical parts and gear assemblies contained in Radio Receiving Set AN/URR–29 have been initially lubricated at the factory. Refer to paragraph 105 for additional lubrication information.

41. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions, such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials. Some of the troubles encountered are:

(1) The effects of fungus growth and excessive moisture on resistors, capacitors, coils, chokes, transformer windings, etc.

(2) Electrolytic action, often visible in the form of corrosion, takes place in capacitors, resistors, coils, chokes, transformer windings, etc., causing eventual breakdown.

(3) Breakdown of insulation on hook-up wires and cables. Fungus growth accelerates deterioration.

(4) Moisture forms on terminal boards and insulation strips, causing flashovers.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and excessive moisture. This treatment is fully explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are fully explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas

subject to extremely high temperatures, low humidity, and excessive sand and dust are fully explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69, Lubrication of Ground Signal Equipment. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders.

42. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up the bared surfaces. Use #00 or #000 sandpaper to clean the surface down to the bare metal; obtain a bright smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case before cleaning corroded metal with Solvent, Dry Cleaning (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations. Refer to TM 9-2851, Painting Instructions for Field Use, for painting instructions.

Section IV. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

43. Scope

a. The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is necessarily limited in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. Accordingly, trouble shooting is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out tubes, cracked insulators, etc.

b. The paragraphs which follow in this section help in determining which of the components (such as the main unit, r-f unit, or power supply), is at fault, and in localizing the fault in that component to the defective stage or item (such as a tube or fuse). Complete trouble localization procedures and necessary follow-up repairs are discussed in chapter 6.

44. Visual Inspection

a. Failure of this equipment to operate properly will usually be caused by one or more of the following faults:

(1) Improper setting of controls.

(2) Worn, broken, or disconnected cords or plugs.

(3) Burned-out fuses.

(4) Wires broken because of excessive vibration.

(5) Defective tubes.

(6) Inactive (dirty or cracked) crystals.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment.

c. Visually inspect the antenna system for obvious abnormalities.

45. Sectionalization of Trouble to a Unit

a. General. Sectionalization of trouble to a unit of Radio Receiving Set AN/URR–29 consists of tracing the fault to a unit or circuit responsible for the abnormal operation of the receiver. Localization, discussed in chapter 6, means tracing the fault to a particular defective component part. Radio Receiving Set AN/URR–29 consists of three units: the main unit, the power supply, and the r-f unit. The r-f unit consists of three sections; first mixer, second mixer, and first hfo. The following information is presented as an aid in tracing a defect to a unit or section.

(1) Observing the performance of the receiver during normal operation and keeping a record of meter readings will often sectionalize the fault to a particular stage when breakdown occurs. See the equipment performance

checklist (par. 47) for normal operating indications.

(2) If only one unit is inoperative, the trouble is probably in that unit and generally the result of a defective tube or (for the power supply) an open fuse. Check the line fuse and tubes at an early stage of the trouble-shooting procedure.

(3) Replace the unit or section suspected of being faulty with one known to be good. If the replacement corrects the trouble, the one removed is faulty.

b. Resistance Measurements. When operational failure occurs, and the trouble is not a defective tube or fuse, the next most common form of trouble is a shorted component part in the B+ distribution circuit. A quick, accurate method of isolating the unit or section containing a B+ short is to make resistance readings at the interconnecting jacks. The following charts indicate the proper resistance readings for the jacks of all units and sections as measured from the pin indicated to ground.

(1) *Power Supply Jack J604.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
1	0	9	NC
2	NC	10	100K
3	inf.	11	NC
4	NC	12	NC
5	inf.	13	0
6	inf.	14	.5
7	inf.	15	2.5
8	inf.		

(2) *Main Unit, Power Supply Jack J303.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
1	0	9	NC
2	inf.	10	20K*

(2) *Main Unit, Power Supply Jack J303.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
3	inf.	11	NC
4	inf.	12	NC
5	inf.	13	0
6	inf.	14	inf.
7	inf.	15	2.8
8	inf.		

*OPERATION switch in AGC position.
R.F. GAIN-SQUELCH control set to mid-position.

(3) *Main Unit, R-f Unit Jack J304.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
1	0	9	20K**
2	inf.	10	20K**
3	127K*	11	NC
4	inf.	12	NC
5	inf.	13	0
6	inf.	14	inf.
7	39 "	15	inf.
8	21K**		

*OPERATION switch in AGC position.
**CALIBRATE switch to ON.
OPERATION switch in AGC position.
R.F. GAIN-SQUELCH control set to mid-position.

(4) *R-f Unit, Main Unit Jack J105.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
1	0	9	inf.
2	inf.	10	inf.
3	inf.	11	NC
4	inf.	12	NC
5	inf.	13	0

(4) *R-f Unit, Main Unit Jack J105* (contd).

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
6	inf.	14	inf.
7	16	15	inf.
8	inf.		

(5) *R-f Unit, First Mixer Section, P103.*

Pin No.	Resistance (ohms)
A	inf.
B	inf.
D	6.5
E	inf.
H	0

(6) *R-f Unit, Second Mixer Section, J102.*

Pin No.	Resistance (ohms)
A	0
B	inf.
C	.5
D	inf.

c. Antenna. Antenna troubles in Radio Receiving Set AN/URR–29 occur less frequently than troubles in other parts of the set. However, the antenna cannot be overlooked as a possible source of trouble. Inspect the antenna for rust, corrosion, damaged insulators or elements, and inspect the input cable for breaks or other defects.

46. Trouble Shooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 47) will help the operator locate trouble in the equipment. The list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective measures the operator can take. To use this list, follow the items in numerical sequence.

b. Action or Condition. For some items, the information given in the action or condition column consists of various switch and control settings under which the item is to be checked. For other items it represents an action that must be taken to check the normal indication given in the normal indications column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator should perceive as the items are checked. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. A reference in the table to chapter 6 indicates that the trouble cannot be corrected during operation and that trouble shooting at a field maintenance depot is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. However, if the tactical situation requires that communication be maintained and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

47. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
	1.	Antenna.	Connect antenna to antenna input jack J107. For use of antenna cable adapter E101, refer to paragraph 20.		

	Item No.	Item	Action or condition	Normal indications	Corrective measures
	2.	OPERATION switch.	Rotate to OFF.		
	3.	115/230 V switch. (At rear of power supply unit.)	Set to proper position.		
	4.	Power Cable Assembly CX-2639/U.	Connects to power source.		
PREPARATORY	5.	AUDIO OUTPUT jacks J305 and J306.	Connects headset or speaker to audio output.		
	6.	BAND SELECTOR switch.	Rotate to band 1.		
	7.	CALIBRATE switch.	Rotate to OFF.		
	8.	DIAL LIGHT control.	Rotate to OFF.		
	9.	METER switch.	Set to CARRIER position.		
	10.	R. F. GAIN-SQUELCH.	Rotate fully clockwise.		
	11.	SELECTIVITY switch.	Set to 200 K.C. position.		
	12.	AUDIO RESPONSE.	Set to WIDE position.		
	13.	NOISE LIMITER control.	Rotate to OFF.		

47. Equipment Performance Checklist (contd)

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	14.	B.F. OSCILLATOR control.	Rotate to OFF.		
	15.	AUDIO GAIN 1	Rotate to mid-position.		
	16.	AUDIO GAIN 2	Rotate to mid-position.		
	17.	ANTENNA TRIMMER and OSC. TRIM controls.	These controls are adjusted in item 29.		
START	18.	Operation switch.	Set to STANDBY position.	Filament voltage applied to Radio Receiver R–220/URR.	
	19.	DIAL LIGHT control.	Rotate clockwise to obtain desired illumination.	Dial lamps light.	Check power source. Check fuse F602 and interconnecting cables.
	20.		Allow a 30 second warm-up period before continuing with item 21.		
	21.	OPERATION switch.	Set to AGC position.	A signal or rushing noise heard in headset or speaker.	Power supply rectifier V601 defective. Check headset or headset connectors. Refer to trouble-shooting chart in paragraph 48.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	22.	CALIBRATE switch and TUNING control.	Set CALIBRATE switch to ON and tune to 25 mc.	Meter reads output level[a].	Rock TUNING control to insure proper setting. Check V103 thru V116, V301, V302, V304 thru V307, V316, V318, and V319; Y101, Y102, and Y301; RT301.
	23.	BAND SELECTOR switch and TUNING control.	Rotate to band 2. Tune to 35 mc.	Meter reads output level[a].	Check Y103.
			Rotate to band 3. Tune to 50 mc.	Meter reads output level[a].	Check Y104.
			Rotate to band 4. Tune to 65 mc.	Meter reads output level[a].	Check Y105.
			Rotate to band 5. Tune to 95 mc.	Meter reads output level[a].	Check Y106.
			Rotate to band 6. Tune to 130 mc.	Meter reads output level[a].	Check Y107.
			Rotate to band 7. Tune to 200 mc.	Meter reads output level[a].	Check Y108.
	24.	METER switch.	Set to LIMITER position.	Meter reads output level[a].	Check V308 and V309.
	25.	CALIBRATE switch.	Turn to OFF.		
	26.	METER switch, BAND SELECTOR switch, and TUNING control.	Set METER switch to OUTPUT HIGH and tune for incoming signal.	Signal heard at headset or speaker. Meter reads output level[a].	Check V101, V102, V314, V315, V317, V322, and V324.

47. Equipment Performance Checklist (contd)

	Item No.	Item	Action or condition	Normal indication	Corrective measures
EQUIPMENT PERFORMANCE	27.	METER switch.	Rotate to the OUTPUT LOW position.	Panel meter reads output level[a].	Check V317 and V322.
	28.	NOISE LIMITER control.	Rotate clockwise.	Background noise decreases.	Check V315.
	29.	ANTENNA TRIMMER control.	Adjust for maximum volume in headset or speaker.	Volume rises to a maximum at one setting.	Check mechanical coupling to C101. Check V101 and V102.
	30.	SELECTIVITY switch.	Rotate to 10 K.C.	Receiver operates at maximum selectivity.	Refer to paragraph 22. Check filter FL302 by substitution.
	31.	SELECTIVITY switch.	Rotate to 50 K.C.	Receiver operates at normal selectivity.	Refer to paragraph 22. Check filter FL303 by substitution.
	32.	SELECTIVITY switch.	Rotate to 200 K.C.	Receiver operates at minimum selectivity.	Refer to paragraph 22. Check filter FL304 by substitution.
	33.	AUDIO RESPONSE switch.	Rotate to MEDIUM.	Audio frequency response decreases.	Refer to paragraph 22. Check filter FL305 by substitution.
	34.	AUDIO RESPONSE switch.	Rotate to SHARP.	Audio frequency response decreases.	Refer to paragraph 22. Check filter FL306 by substitution.
	35.	OPERATION switch and R.F. GAIN–SQUELCH control.	Set to MGC position, rotate counterclockwise.	Volume decreases.	Check V303.
	36.	OPERATION switch.	Set to AM SQUELCH position.	When no signal is being received rotate SQUELCH control clockwise until rushing noise is heard at headset. Back off control until receiver squelches.	Check V312, V313, and V317.

	Item No.	Item	Action or condition	Normal indication	Corrective measures
EQUIP.	37.	OPERATION, SELECTIVITY, and METER switches.	Set OPERATION switch to FM SQUELCH; SELECTIVITY switch to 200 K.C. METER switch to DISC.	Meter reads 25 ua.	Check V310 and V311.
	38.	CALIBRATE switch.	Turn to ON.		
PERF.	39.	B.F. OSCILLATOR control.	Rotate to 0 position.		
	40.	BAND SELECTOR switch and TUNING control.	Rotate to band 1; tune to 25 mc.	Slight adjustment of B.F. OSCILLATOR control produces a zero beat in headset or speaker.	Check V321. Oscillator misalined; refer to paragraph 63.
STOP	41.	OPERATION switch.	Rotate to OFF.		

[a]Normal readings depend upon the individual receiver. Record these for future reference.

48. Trouble-shooting Chart for Radio Receiving Set AN/URR–29

Symptom	Probable trouble	Correction
1. Receiver output drifts.	1. Voltage regulator inoperative, or open first hfo heating element.	1. Check V323; replace if necessary. Check continuity of heating element.
2. Weak or no output.	2*a*. 230/115 v switch at rear of power supply set to 230 v position; source voltage 115 volts. *b*. V601 defective.	2*a*. Change position of switch. *b*. Replace tube.
3. Fuse F602 opens repeatedly.	3. 230/115 v switch at rear of power supply set to 115 v position; source voltage 230 volts.	3. Change position of switch; replace fuse.
4. Power supply rectifier drawing excessive current. (Tube plates appear red).	4. Shorted tube or component part in B+ circuit.	4. Refer to resistance measurements in paragraph 45.
5. Intermittent loss of signal accompanied by noise bursts.	5. Defective antenna or antenna transmission line.	5. Check antenna for eccentricities. Refer to paragraph 20.
6. Volume fluctuates.	6. No agc action due to defective tube(s).	6. Check V101, V102, V113, V307, V314, V316 or V319; replace if necessary.
7. No aux i-f output at J302.	7. Defective V318.	7. Check and replace if necessary.
8. No aux diode output at J301.	8. Defective V318, V319, or V320.	8. Check and replace if necessary.

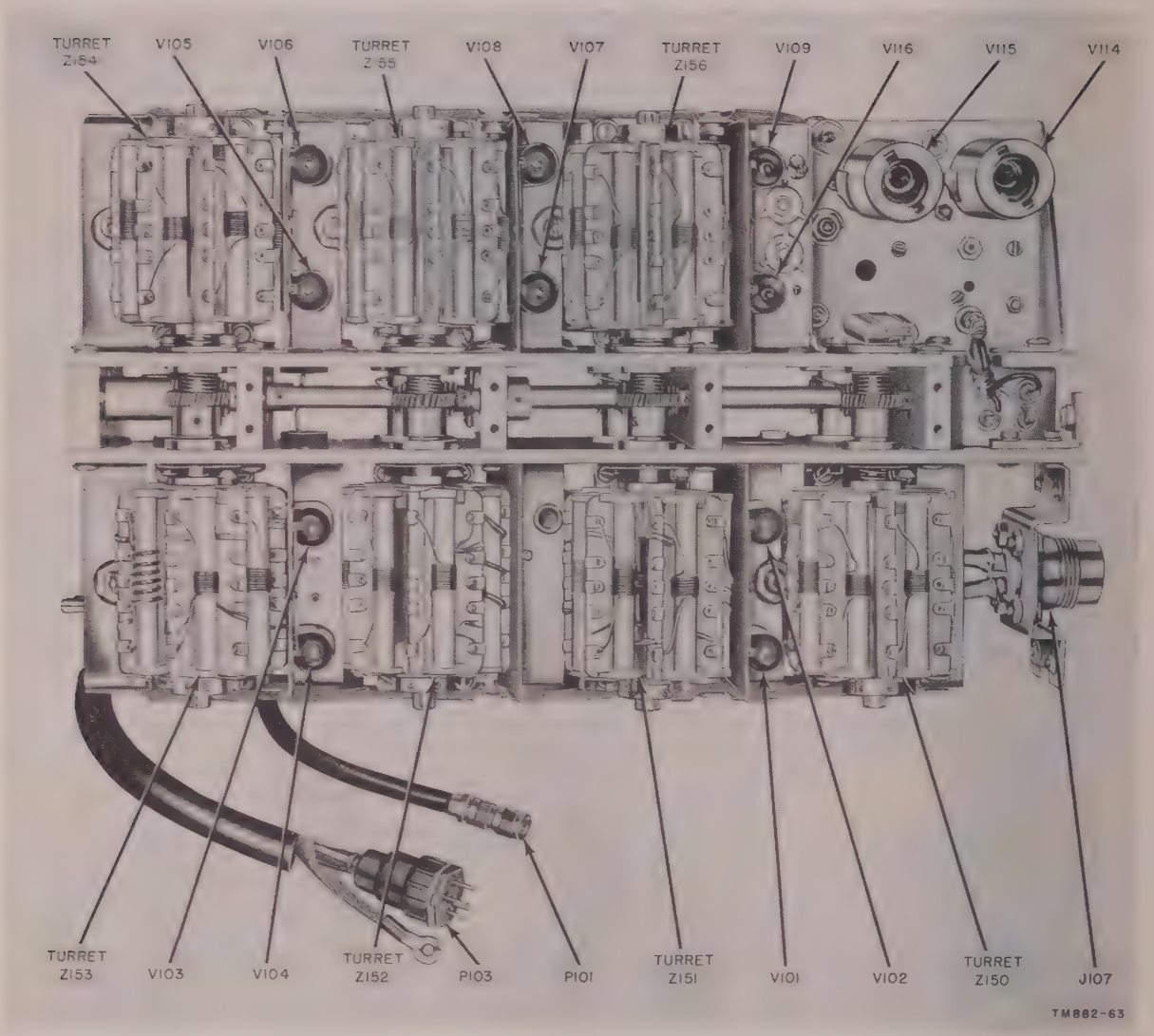


Figure 29. Radio Receiver R–220/URR, r-f unit, turret side.

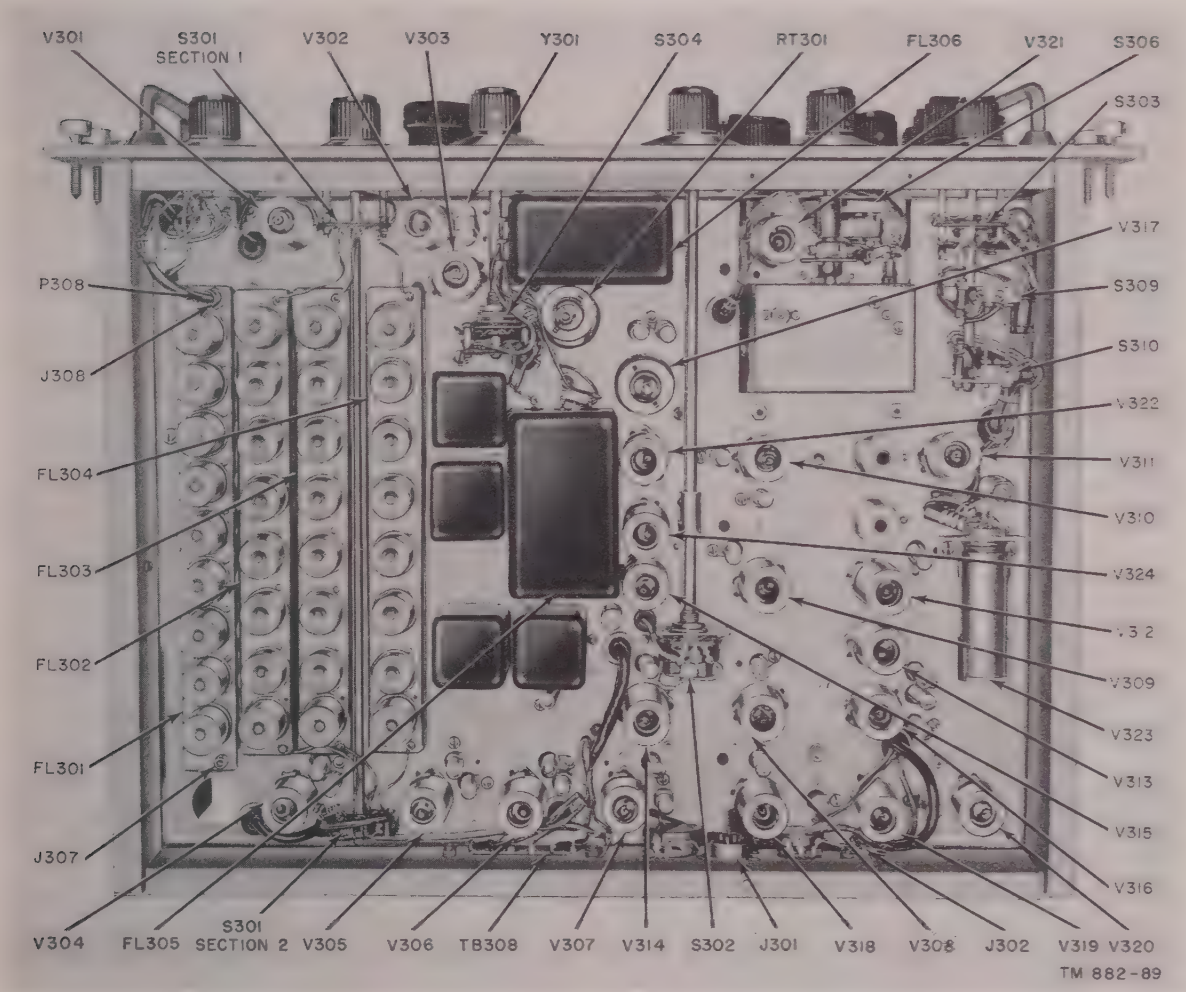


Figure 30. Radio Receiver R–220/URR, main unit, location of tubes.

CHAPTER 5

THEORY

Section I. BLOCK DIAGRAM

49. General

(fig. 122)

The signal path through Radio Receiver R–220/URR is shown on the functional block diagram (fig. 122). Arrows trace the progress of the signal from the point where it is received from the antenna to the various outputs. The operation of the receiver is described on the basis of its use with Power Supply PP–660/URR. The block diagram shows what the receiver consists of and the basic connections between stages. Detailed circuitry and power distribution are shown in the schematic diagrams (figs. 125 and 132).

50. R-f Input to Third Mixer

The carrier signal, which may be c-w, a-m or f-m when it is picked up on the antenna, is amplified in the r-f amplifier (V101, V102) and fed to the first mixer (V104). Image rejection is achieved by the use of triple conversion, which reduces the vhf signal, ranging from approximately 20 mc to 230 mc, down to an ultimate intermediate frequency of 455 kc. The first conversion takes place in the first mixer stage (V104), where the signal frequency (19.74 to 237.97 mc) is combined with the output of the first hfo (V110) to produce a difference frequency ranging between 6.09 mc and 48.75 mc. The signal which is generated in the first hfo passes through a series of buffers and multipliers to the first mixer. The stability of the first hfo is increased by means of a thermostatically controlled heater plate which maintains a constant ambient temperature, and by regulated plate and filament voltages. For precise frequency adjustment and dial calibration, a crystal controlled calibrating signal from the calibrator oscillator (V115) is also injected into the first mixer when dial calibration is necessary. The mixer output is amplified by the first i-f amplifier (V113) and enters the second mixer (V112) where it beats with the frequency (7.84 to 47.0 mc) generated in the second hfo (V111) to produce a difference frequency of 1.75 mc. This frequency, the result of the first two conversions, is determined by means of a band switching arrangement which selects one of seven positions corresponding to the band being used (see par. 83). The 1.75-mc output from the second mixer passes through the 1.75-mc filter (FL301) to the third mixer (V301), where it is combined with the 2205-kc signal originating in the third hfo (V302).

51. Third Mixer to First Audio Amplifier

a. The difference frequency from the third mixer output is 455 kc and this signal passes through one of the three 455-kc selectivity filters (FL302, FL303, FL304) to the 455-kc i-f strip, consisting of four amplifiers in cascade (V304, V305, V306, and V307). From here the signal is fed to the f-m circuit, the a-m circuit and the auxiliary circuit.

b. The f-m circuit consists of an i-f amplifier (V308), two limiters (V309 and V310), and a discriminator (V311). A portion of the second limiter output is also applied to noise amplifier V312, followed by noise rectifier V313, where a d-c voltage is obtained. This voltage is applied through squelch tube V317A to first audio amplifier V317B, along with the audio frequency output from the discriminator.

c. The a-m circuit consists of a-m i-f amplifier V314 and a-m detector V315A (the output of which is applied to the first audio amplifier). Voltage from the a-m detector is also applied to the noise suppressor (V315B). The output from the bfo (V321), when used, is sent to the a-m detector where it beats with the output

from the 455-kc a-m i-f amplifier to produce the desired audio beat note for the reception of c-w signals.

d. The auxiliary circuit consists of two i-f amplifiers (V318 and V319), and an auxiliary diode (V320) which rectifies a-m signals. Special output terminals are provided, one from the first auxiliary i-f amplifier to furnish a 455-kc output and the other from the rectified output of the auxiliary diode.

52. First Audio Amplifier to Audio Frequency Output

From the first audio amplifier the signal continues, either directly or through one of the audio response filters (FL305 or FL306) to the second audio amplifier (V322), from which a 600-ohm balanced audio output is available. Output from the second audio amplifier is also applied to the audio power amplifier (V324), which provides the power to drive the speaker. The output of the power amplifier is available at either of two 600-ohm speaker jacks on the front panel or at the terminal board at the rear of the main chassis.

53. Gain Control Circuits

a. The automatic gain control circuit receives excitation voltage from the f-m i-f amplifier. This voltage is rectified by the agc diode (V316) and varies the bias of the r-f and i-f stages in proportion to signal strength, thus automatically controlling the gain of the receiver.

b. The manual gain control voltage, which originates in the 2205-kc oscillator, is rectified by the mgc diode (V303), and sent to the gain control circuits of the receiver. Selection of either agc or mgc is a function of the OPERATION switch on the front panel.

54. Power Supply Unit

Power Supply PP–660/URR provides all power for the receiver plate, screen, and filament circuits and for the oscillator heater element. Compensation for filament and plate voltage variation is obtained in the first hfo by using a voltage regulator tube to control plate voltage and a ballast tube to regulate the filament current. The input to the power supply may be either 115 or 230 volts a-c, 48 to 62 cycles.

Section II. CABLING AND CONNECTIONS

55. Cabling Diagram

(fig. 123)

Connections between all units and sections comprising Radio Receiver R–220/URR are shown on the cabling diagram (fig. 123). Arrows indicate the various coaxial and power cables and other connections. Signal connections are shown at the top of the diagram, running from left to right. Power connections can be traced from right to left, at the bottom of the diagram.

56. Units and Sections

Radio Receiver R–220/URR consists of three distinct units, shown on the cabling diagram by means of dotted lines. These units, from left to right, are the r-f unit, the main unit, and the power supply unit. Sections and subsections within the units are also represented by dotted lines.

a. R-f Unit. The r-f unit is subdivided into three sections, each containing two or more stages or assemblies.

(1) *First mixer section.* The first mixer section consists of the r-f amplifier, calibrator oscillator and buffer, first hfo buffer, three multipliers, the third multiplier buffer, and the first mixer.

(2) *First hfo section.* The first hfo is contained in a section by itself, but associated with it, and a part of the assembled section, is the oscillator heater element.

(3) *Second mixer section.* The second mixer section consists of the first i-f amplifier, second mixer, and second hfo.

b. Main Unit. The main unit contains all signal stages of the receiver from the 1.75 mc input to the various outputs, inclusive. The 1.75-mc filter section consists of FL301 with its input and output jacks. There are two output sections on the main unit—the front panel, with

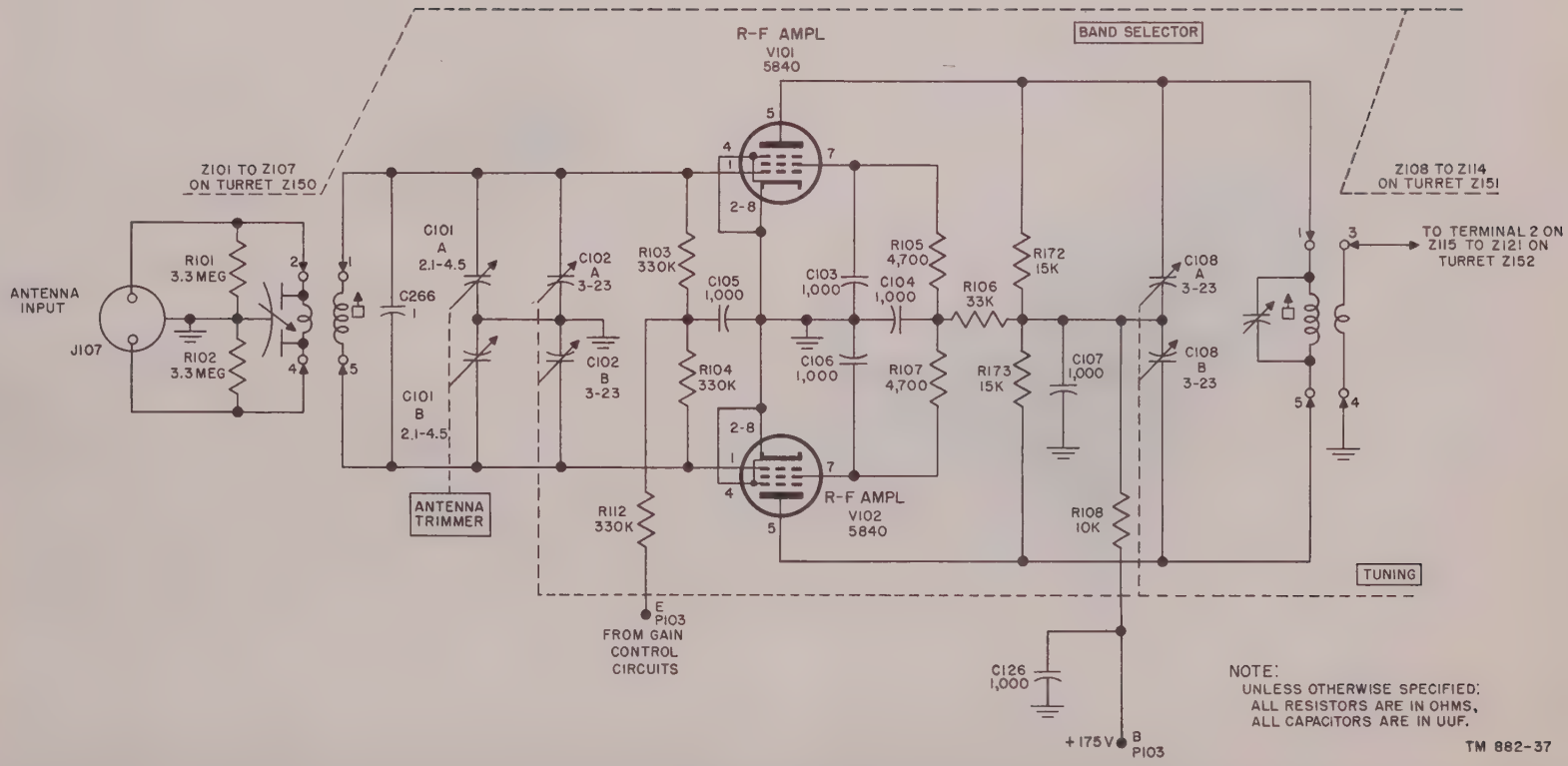


Figure 31. Input circuit and r-f amplifier.

jacks J305 and J306, and the rear apron, with jacks J301, J302, and terminal board TB308.

c. Power Supply Unit. The power supply unit contains the a-c power input jack, J603, and the main power output jack, J604.

57. Jacks and Plugs

(fig. 124)

a. General. The chart in paragraph 103 lists all the jacks and plugs which are used in Radio Receiving Set AN/URR–29 as well as the cables supplied with the radio set and the components which the jacks, plugs, and cables connect. Figure 124 shows all jacks and plugs interconnected.

b. Power Connections. Main power cable W304 connects the power supply unit with the main unit by means of plugs P604 and P303; P604 connects with J604 in the power supply, and P303 is plugged into J303 in the main unit. Power for the r-f unit is obtained when the r-f unit power cable (W302) interconnects J304 and J105. The second mixer power cable connects J105 with J102 in the second mixer. Fixed connections within the r-f unit furnish power from J105 to J103 for the first mixer section and directly to the first hfo section. Power for the oscillator heater element is available at J104, mounted in the first hfo section. A power cable from the heater element completes the connection when P104 is plugged into J104.

c. Signal Connections. The r-f output from the first hfo is fed to the first mixer section when plug P108 is connected to jack J108. The r-f lead is a short length of No. 22 wire. The signal from the antenna enters the first mixer section at J107. The first and second mixer sections are connected by coaxial cable when P101 is plugged into J101. Another short coaxial cable connects the second mixer output, in the r-f unit, with the filter section input, in the main unit. This connection is made by inserting P306 in J106 and inserting P307 in J307. A coaxial lead from the third mixer input connects with J308 in FL301 by means of P308.

Section III. STAGE ANALYSIS

58. Antenna Input

Antenna Assembly AS–574/URR consists of a monopole mast section insulated from ground, together with a dipole antenna designed to provide efficient coverage from 20 to 230 mc. The incoming signal picked up on the antenna travels along a shielded twinaxial lead-in to J107.

59. Radio Frequency Amplifier

(fig. 31)

a. General. The signal is amplified in the r-f amplifier and passes into the first mixer at the input frequency. R101 and R102, connected between each side of the primary of Z150 and ground, ground any static charge in the antenna or in the coupling circuits. The r-f amplifier stage consists of two matched pentodes, V101 and V102, connected in push-pull and operating as class A voltage amplifiers. Grid and plate circuits are both balanced and tuned. Link coupling is used both in the input circuit and the output circuit. The operating frequency is determined by a switching arrangement geared to the front panel BAND SELECTOR and TUNING controls, which selects the desired grid and plate tanks from the turret assemblies (par. 83).

b. Purpose. Radio-frequency amplification ahead of the first mixer discriminates against interference from images at the lower radio frequencies and improves selectivity and sensitivity at all frequencies. The r-f stage serves to isolate the mixer from the antenna and the push-pull arrangement reduces second-harmonic distortion and provides a sufficiently large signal to the mixer grid.

c. Push-pull Amplifier.

(1) An increase in voltage output is obtained by the use of the push-pull circuit, which has the grids and plates of tubes V101 and V102 connected to opposite ends of the balanced circuits, the grids to Z150 and the plates to Z151. At any instant, the ends of the inductance between terminals 1 and 5 of Z150 will be at opposite polarity with respect to the cathode, so the grid of one tube is swung positive at the same instant that the grid of the other

is swung negative. Therefore, the voltages and currents of one tube are 180 degrees out of phase with those of the other tube. Distortion resulting from even harmonics is balanced out in the plate circuit. The split-tank grid circuit is tuned by C102A and C102B, which are ganged by means of a gear train, with capacitors in succeeding stages, and operated by the TUNING control on the front panel. (See par. 83.) C101A and C101B are ANTENNA TRIMMER capacitors, also controlled from the front panel. C266 fixes the minimum circuit capacitance at the correct value. The output of V101 and V102 is applied to the plate tank circuit, Z151, and tuned by C108A and C108B, ganged to the TUNING control.

(2) Since the r-f amplifier is operated class A, both tubes are conducting for 360° of the grid input cycle. Because the tubes are connected in push-pull, when the grid of one tube is going positive the grid of the other tube is going negative. The plate current of the tubes flows through their respective plate load resistors, R172 and R173, placing a charge on C108A and C108B. For example, when the grid of V101 is going positive, the plate current is increasing, which charges C108A, negative on the plate side and positive at the junction of C108A and C108B. At the same time that the grid of V101 is going positive, the grid of V102 is going negative, decreasing V102 plate current and causing C108B to discharge. This makes Z151 negative at the bottom and positive at the top. When the grid of V101 swings negative and the plate current is decreasing, C108A is discharging through the primary of Z151, making Z151 negative at the top and positive at the bottom. The current through Z151 will be constantly varying in proportion to the input signal. The current in Z151 produces an a-c voltage which is link-coupled to the following stage.

(3) Automatic or manual gain control voltages, applied at the junction of R103 and R104, control the amplification of the tubes by varying the negative grid bias. R112 and C105 decouple the gain control circuit from the grid circuit.

d. Band Selection. The BAND SELECTOR control on the front panel is used to match the proper coil and capacitor combination to the band being tuned. These impedances, Z150 and Z151, are turret assemblies, each consisting of seven coils, one for each of the seven frequency bands on which the receiver operates. Z150 consists of Z101 to Z107, connected between terminals 1 and 5. Z108 to Z114 are connected between terminals 1 and 5 on Z151. Slug tuning is used on each band to aid in tracking. Z151 also has a tracking capacitor shunted across each coil and additional tracking capacitors (fig. 132) consist of C251 across Z107, C252 across Z113, and C253 across Z114. The antenna link, between terminals 2 and 4 on Z150, consists of one turn for each band. Variable capacitors across the links are used to balance the input circuit. All links on Z151 consist of a single turn.

e. Voltage Supply. B+ from pin B on plug P103 is applied to the r-f amplifier stage through the B+ decoupling resistor R108 and the decoupling capacitors C107 and C126. Decoupling is provided by R106 and C104 for the screen grids of the tubes. R105 and R107 are screen grid voltage dropping resistors. C103 and C106 are screen grid bypass capacitors.

60. First High-frequency Oscillator

(figs. 32, 33, 34, and 35)

a. General. The first high-frequency oscillator (V110) is a vfo (variable frequency oscillator) employing a modified Colpitts oscillator circuit with each part specially designed and critically placed to maintain a frequency stability within .002 percent.

b. Purpose. The first hfo is variable in order to provide a tunable output to beat with the incoming signal in the first mixer. This produces a new radio frequency, the first i-f.

c. Circuit Description. An oscillator is an amplifier with its circuit arranged so that there is enough positive feed-back to sustain oscilla-

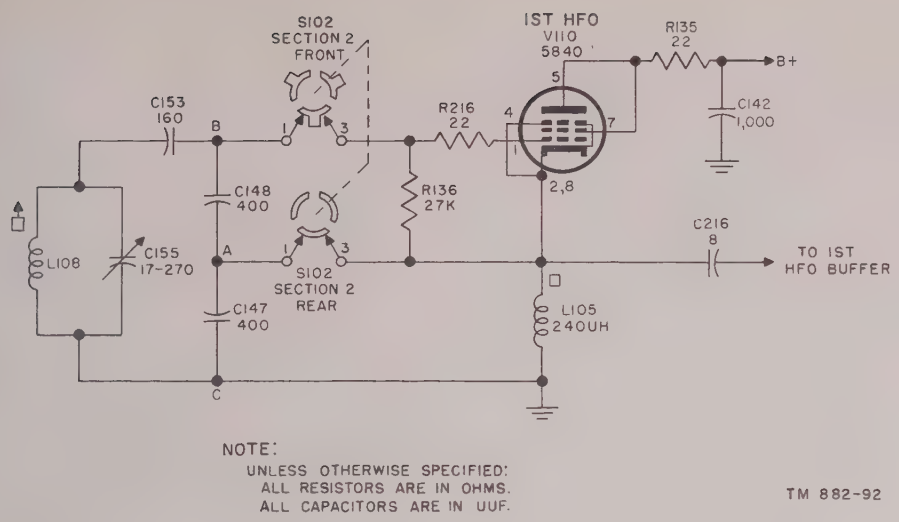


Figure 32. Modified Colpitts oscillator, simplified schematic.

tions. The desired frequency of oscillation is obtained by using a resonant circuit tuned to that frequency.

(1) *Colpitts oscillator* (fig. 32). The modified Colpitts oscillator shown in figure 32 is of the shunt-fed, grounded-plate variety, the major frequency-determining components being L108 and C155. The cathode of the tube is connected between grid and plate ends of the tank circuit, at the junction of the capacitive divider network at A, and the grid and ground are connected to opposite ends of the tuned circuit at B and C. When r-f currents flow through L108 in the grid tank circuit, the top of the coil will be of opposite polarity to the bottom and a voltage drop occurs across the oscillator capacitive divider network, C148 and C147. The junction of C148 and C147, to which the cathode is connected, will be at an intermediate potential. The excitation voltage across C148 causes the oscillations. The a-c output of the oscillator is taken across C147. The ratio of excitation voltage to a-c output voltage is determined by the ratio of the reactances of C147 and C148. The grid coupling capacitor C153 and the grid-leak resistor R136 supply grid-leak bias. In addition to providing the feedback voltage, the capacitors C148 and C147 also mask the tube capacity so that replacing the tube will have no serious effect on the operation of the oscillator. The cathode r-f choke L105 has low distributed capacity and resonates at a frequency lower than the lowest oscillator frequency, offering capacitive reactance at all higher frequencies. The output of the oscillator is coupled to the control grid of the first hfo buffer (V116) by C216. The first hfo uses a pentode tube, connected as a triode, to reduce variations of output voltage across the band.

(2) *Band switching* (fig. 33). The one-tube circuit, V110, is switched between two tuned circuits at the cathode and grid, points A and B. The seven bands are divided into two groups, the odd-numbered bands (1, 3, 5, and 7) oscillating at frequencies ranging from 13.6523 to 23.6523 mc and the even-numbered bands (2, 4, and 6) from 9.674 to 16.761 mc. There is a separate tank circuit for each of the two groups, one for the *odd bands* and one for the *even bands*. Since only one tank is used at a time, the unused tank is grounded through S102 when

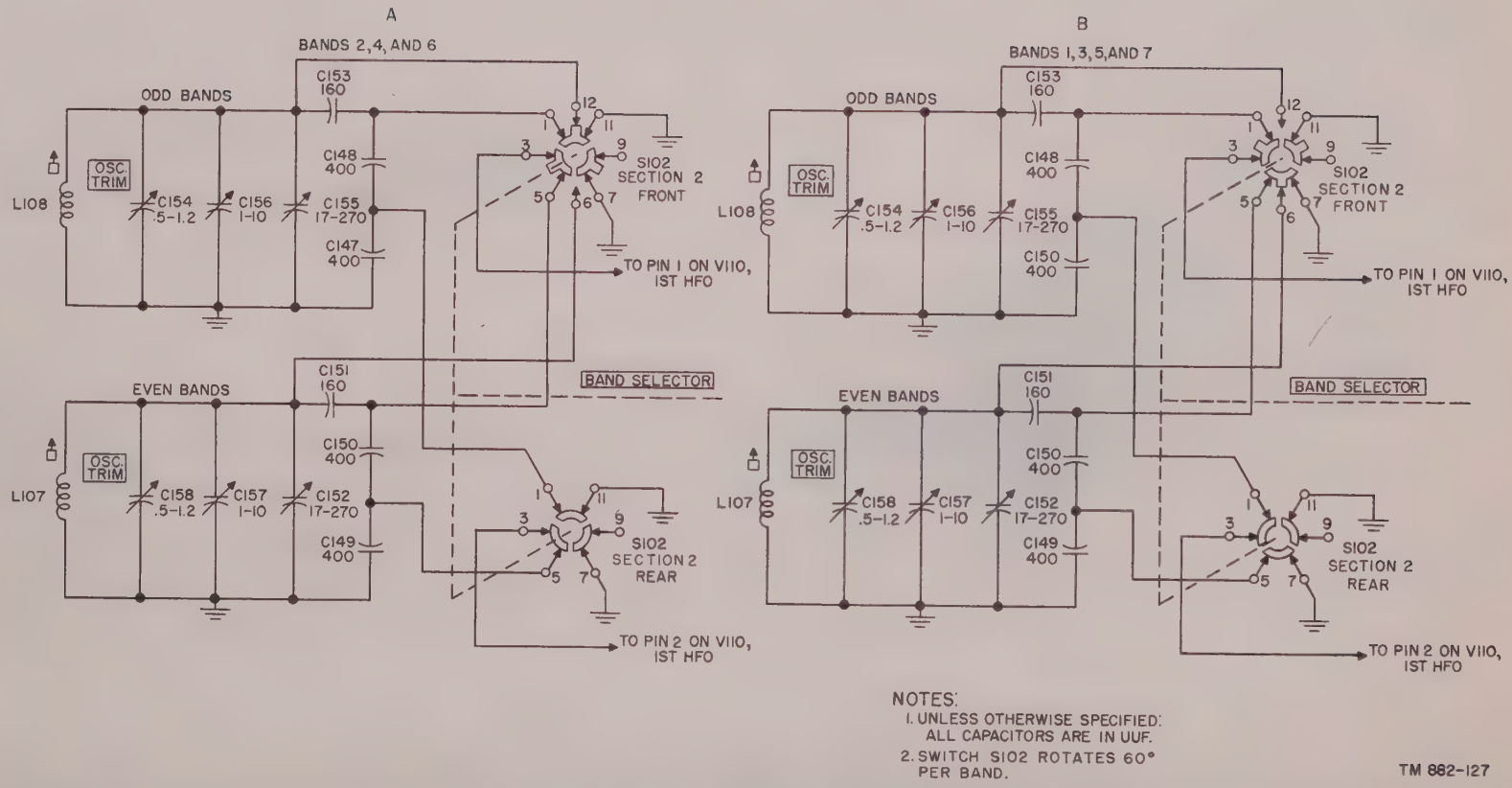


Figure 33. First hfo band switching.

the other tank is switched into the circuit. The BAND SELECTOR which selects the appropriate coil from the turrets also rotates S102, which alternately switches in either the odd-band tank or the even-band tank. Figure 33A shows the switch in position for the even bands. Rotating S102 either clockwise or counterclockwise will transfer V110 to the odd-band position (B, fig. 33).

(3) *Tracking.* Tracking of the odd and even band tank circuits is accomplished by adjusting two sets of trimmer capacitors, C154 and C156 for the odd bands, and C157 and C158 for the even bands. C154 and C158 are adjusted from the front panel by means of the OSC. TRIM control; C156 and C157 are adjusted through holes in the top of the r-f unit. Another set of holes in the r-f cover permits slug adjustment of the oscillator tuned circuit coils, L107 and L108.

d. Voltage Supply (fig. 34). The plate and screen grid of V110 are connected together and B+ is supplied from the power supply through the regulated output of the main unit, entering the r-f unit at pin 8 on J105. The regulated voltage is filtered by the low-pass, two-section, pi-type filter composed of C220, L126, C218, L106, and C142. R135 and R216 are parasitic suppressors. Filament current for V110 is obtained from a 6.3-volt a-c source in the power supply, where it is held constant by means of the ballast tube, RT301. Filament current enters the r-f unit through pin 7 on J105 and is filtered by C219, L127, C217, and L104.

e. Heater Element (fig. 35). The oscillator section is kept at a constant temperature of 149° Fahrenheit (65° C) by the oscillator heater element, which is composed of two sections. The A section is supplied with 115 volts a-c by Power Supply PP–660/URR. When a d-c power supply is used, the B section of the heater is supplied with 26 volts d-c. In either case, the heater dissipates 90 watts while operating. The temperature is regulated by S103, the 65° C thermostat.

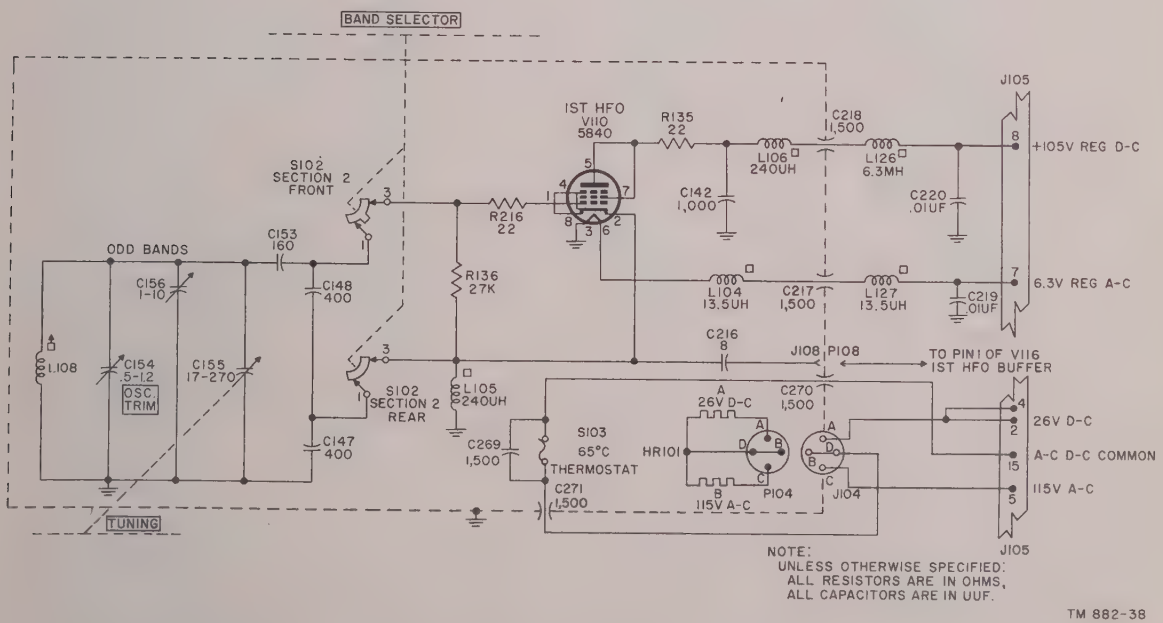


Figure 34. First high-frequency oscillator.

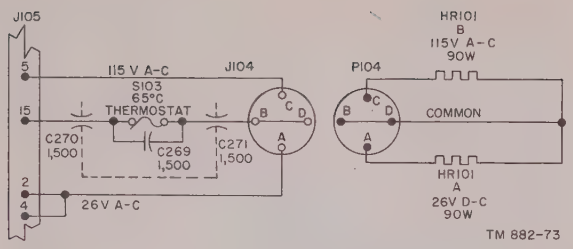


Figure 35. Oscillator heater assembly.

61. First Hfo Buffer and First Multiplier

(fig. 36)

a. First Hfo Buffer. The first hfo buffer consists of a single pentode (V116) connected as an isolating r-f amplifier and capacitively coupled between the first hfo and the multiplier stages.

(1) *Purpose.* If the first multiplier were coupled directly to the first hfo, changes occurring in the plate circuit of the multiplier such as fluctuations in plate voltage, plate-tank tuning, or loading, would reflect changes in the effective input capacitance of the tube. The multiplier would thus react on the frequency of the oscillator if coupled to it directly, changing the frequency of oscillation. The purpose of the first hfo buffer is to preserve frequency stability by securing isolation of the first hfo from output variations in the following stages.

(2) *Theory and application.* The first hfo is coupled through C216 to the first hfo buffer, which in turn is coupled through C141 to the first multiplier. Isolation is improved by the use of a fixed, nonresonant circuit, consisting of R167 and C215 instead of a tuned plate tank. The input signal is developed across R170, which provides grid return to ground. The higher over-all gain of the multipliers and buffers on certain bands is partially compensated for in the first hfo buffer by reducing its B+ voltage on these bands. The plate load and screen voltage dropping resistors are R167 and R168, respectively. A second voltage dropping resistor, R166, is in series with the B+ supply on bands 2 and 4 only. On all other bands, this resistor is shorted out by a jumper across terminals 2 and 4 of Z156, increasing the output so that gain will be uniform on all bands. Further gain compensation is effected in the third multiplier buffer.

b. First Multiplier. The output from the buffer is used to drive the first multiplier (V109), a single pentode. A frequency multiplier is an amplifier that delivers output at a multiple of the exciting frequency. V109 is the first of a series of multipliers used to arrive at the desired output frequency for mixer injection. All multipliers in Radio Receiver R–220/URR operate either as doublers, providing an output at twice the exciting frequency, or as straight amplifiers.

(1) *Purpose.* To maintain a high order of frequency stability, the oscillator is operated at a comparatively low frequency (9.67 to 23.65 mc). Frequency multipliers are then employed to arrive at the desired output frequency.

(2) *Theory and application.* The plate tank circuit of the first multiplier consists of one of the inductances, Z143 to Z149, on turret Z156, chosen by the BAND SELECTOR. The TUNING capacitors C136A and C136B, and trimmer capacitors C211A and C211B, are connected across this tank circuit, with their rotors grounded to present a balanced input to the second multiplier control grids. C134 is part of the balanced tank network and is used to fix the minimum circuit capacitance at the correct value. On bands 2 to 7, V109 doubles the output frequency of V116. On band 1, the plate circuit is tuned to resonate at the input frequency, and the first multiplier acts as a second buffer.

c. Voltage Supply. Plate and screen voltage for both V116 and V109 is decoupled and bypassed by R163 and C140. The plate and screen grid circuits of V109 consist of plate load resistor R132, r-f bypass capacitors C139 and C250, and screen voltage dropping resistor

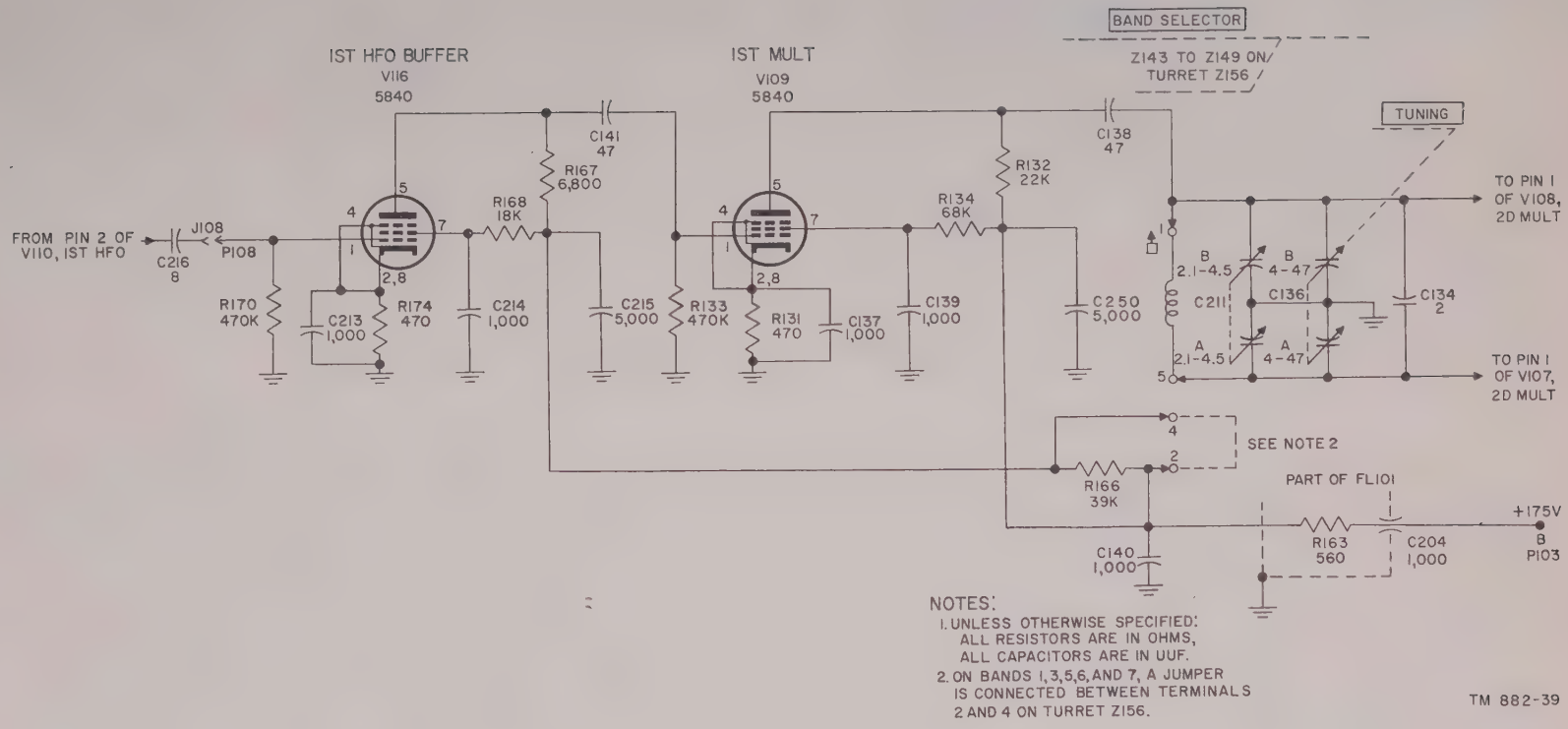


Figure 36. First hfo buffer and first multiplier.

R134. C214 and C215 are r-f bypass capacitors, R174 is the V116 cathode bias resistor, and C213 is the cathode bypass capacitor. R131 is the V109 cathode bias resistor and C137 is the cathode bypass capacitor.

62. Second and Third Multipliers

(fig. 37)

a. General. The output from the first multiplier is doubled only on bands 4, 5, 6, and 7 in the second multiplier; in the third multiplier, doubling takes place on bands 6 and 7 only. Aside from this, the operation of the second and third multiplier stages is identical. The circuits of the two stages are similar except that the output of the third multiplier is applied to a single tube. A lower value of cathode bias is employed in the third multiplier stage than in the second multiplier, in order to maintain the signal at a uniform level, but all other values are the same in the two stages. Each stage employs two medium-mu triodes operated class C with the grids connected in push-pull and the plates connected in parallel to form what is commonly called a push-push circuit. The output from V109, the first multiplier, is applied to the grids of V107 and V108 and the amplified output of the tubes is coupled by C131 to Z155, which presents a balanced input to V105 and V106. The output from V105 and V106 is coupled through C122 to Z154, which is followed by the third multiplier buffer (V103). Plate voltage for both multiplier stages is applied at the junction of R122 and R123 through R128. C140 is a decoupling capacitor. Interstage decoupling takes place in the second multiplier stage through R123 and C127, and in the third multiplier stage through R122 and C124. R126 and R171 are plate load resistors for the second and third multiplier stages, respectively.

b. Second Multiplier. When used as r-f amplifiers with the plate and grid circuits tuned to the same frequency, triodes must be neutralized to prevent undesirable oscillations. On bands 1, 2 and 3, an additional resistor (R215) is inserted in the cathode circuit of V107 and this higher value of cathode bias renders the tube inoperative. V108 remains in operation, with the grid-to-plate capacitance of V107 serving as neutralization. The second multiplier now operates as a conventional single-ended amplifier with the plate tank circuit tuned to the input frequency. On bands 4, 5, 6, and 7, the cathode bias of V107 is reduced to normal by means of a jumper-wire connection on turret Z155. When the jumper wire shorts out R215, tube V107 conducts and the stage is operating as a push-push multiplier. The output frequency is the second harmonic of the input frequency and the circuit is operating as a frequency doubler. Neutralization is not necessary when doubling, since the grid and plate tanks are tuned to different frequencies. The output of the second multiplier stage is fed to a balanced output tank circuit, which is composed of an inductance (Z136 to Z142 on turret Z155, chosen by the BAND SELECTOR) and a capacitance consisting of tuning capacitor C128A and C128B, ganged to the front panel TUNING control, and trimmer C209A and C209B. C133 is part of the balanced tank network, used to fix the minimum circuit capacity at the correct value. C129 and C130 are cathode bypass capacitors. A combination of grid-leak and cathode bias is used in the second multiplier stage. Grid bias is obtained when excitation from the first multiplier causes the flow of grid current. If grid excitation should be removed, there will still be enough bias to protect the tubes from damage.

c. Third Multiplier. On bands 1 through 5, the cathode circuit of V105 must be completed through resistor R214 on turret Z154, and the tube is inoperative, as in the preceding stage. The frequency is doubled on bands 6 and 7 only. Z129 to Z135 on turret Z154, together with C121 and C205, comprise the plate tank of the third multiplier. On bands 1 through 6 additional capacitors are shunted across the tank circuit to improve tracking. C120 and C123 are cathode bypass capacitors. The single-ended output of the third multiplier feeds to the grid of the third multiplier buffer (V103).

63. Third Multiplier Buffer

(fig. 38)

The output of the third multiplier stage is coupled through capacitor C122 to the grid of the third multiplier buffer, V103, which operates as a buffer amplifier. Grid current flows through R117 due to the third multiplier output, generating an automatic bias and this bias is supplemented by the self-bias developed across the cathode resistor, R116. B+ is decou-

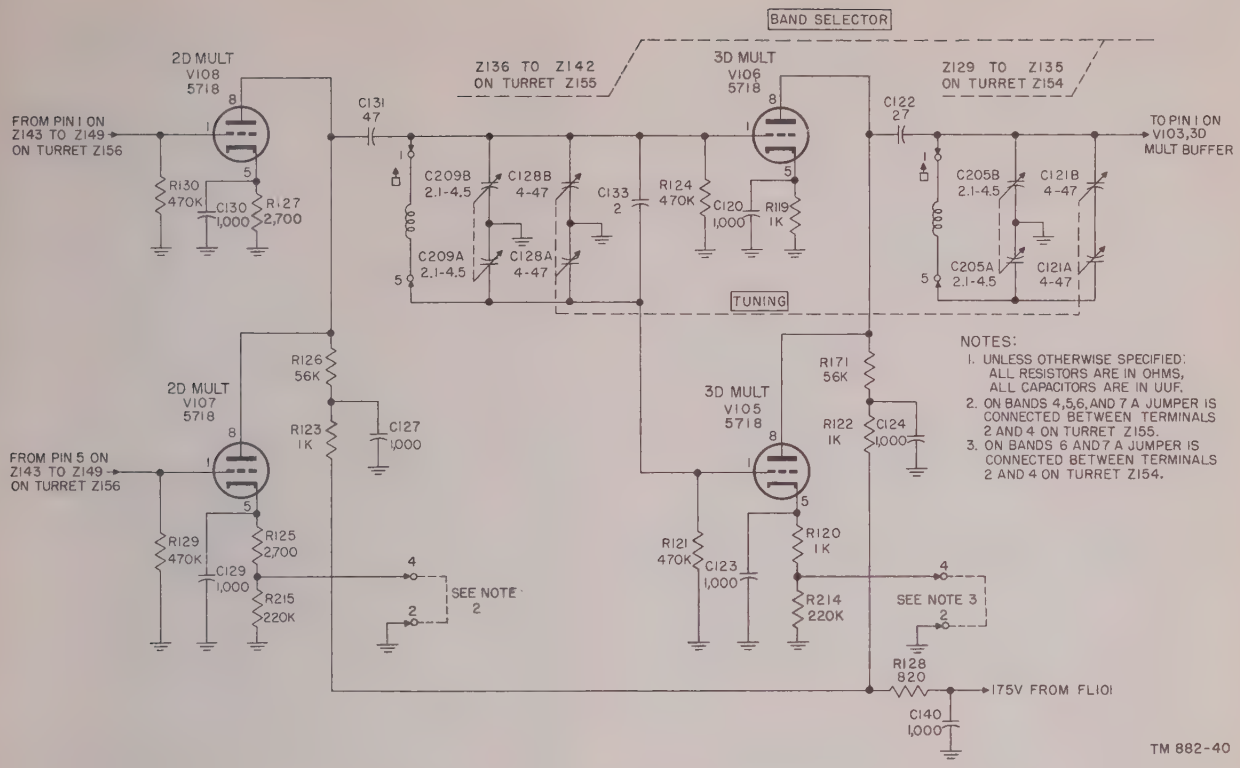


Figure 37. Second and third multipliers.

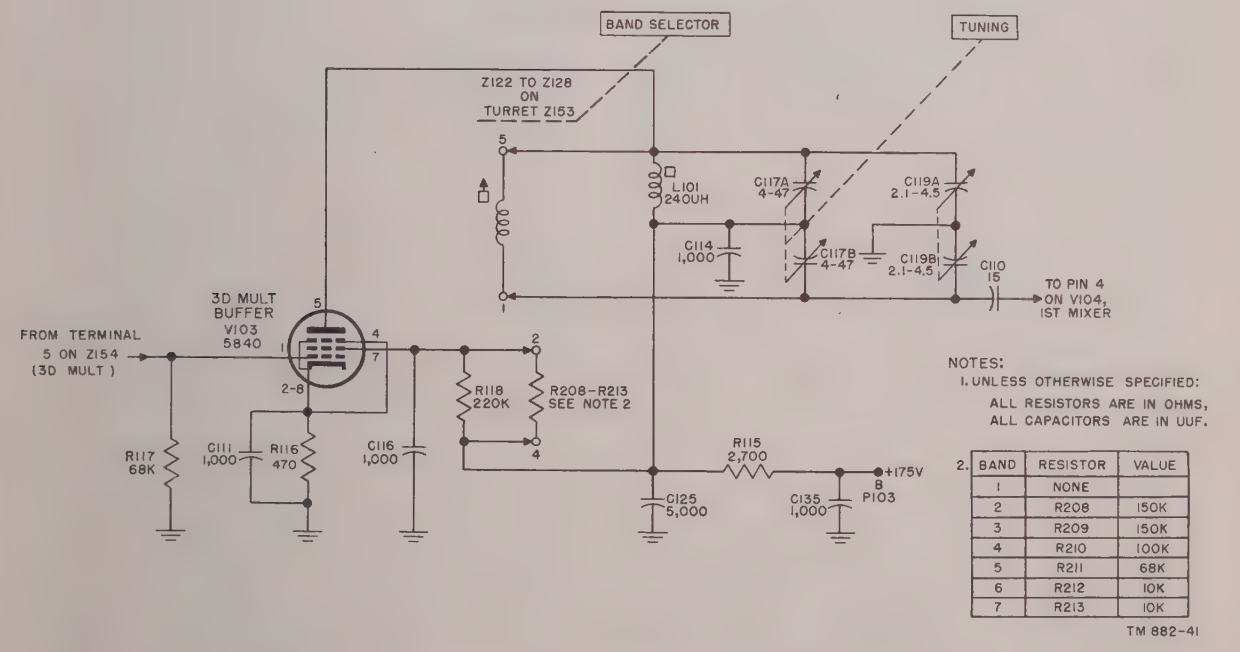


Figure 38. Third multiplier buffer.

pled by R115 and C125, and applied to the plate of V103 through r-f choke L101. On band 1, B+ is applied to the screen grid through R118. On the remaining bands (2, 3, 4, 5, 6, and 7) as the frequency becomes higher, R118 is shunted by progressively smaller resistors, R208 through R213, on turret Z153, resulting in higher screen voltage and increased amplification. The plate tank circuit is composed of one of the inductances (Z122 through Z128 on turret Z153), tuning capacitors C117A and C117B, and trimmer capacitors C119A and C119B. On all bands additional capacitors (not shown in figure 38) are shunted across the tank circuit to improve the tracking. C114 and C116 are bypass capacitors for the plate and screen circuits. C111 is a cathode bypass capacitor. C135 is a B+ line bypass capacitor. Z153 is ganged to the BAND SELECTOR control on the front panel and C117A and C117B are ganged and operated from the front panel by the TUNING control. The output from the third multiplier buffer tank is fed through C110 to the first mixer circuit.

64. Calibrator Oscillator and Buffer

(figs. 39 and 40)

a. General. The calibrator oscillator and buffer consist of a pentode crystal oscillator stage, with external feedback and a low C plate tank circuit, driving a pentode buffer stage. A high order of frequency stability is obtained through the use of a quartz crystal, which is ground to oscillate at 5 mc. The output frequency to the first mixer is further stabilized by the constant load presented by the buffer.

b. Pentode Crystal Oscillator (fig. 39). The crystal, Y101, acts as a sharply tuned resonant circuit in the grid circuit of the oscillator. Phasing capacitor C198, connected in parallel with the crystal, is used to vary the frequency slightly. This is accomplished by changing the shunt capacity of the crystal. Grid-leak resistor R161 furnishes the operating bias when the tube is oscillating. The plate circuit is slug-tuned by L124, in parallel with C188, to form a plate tank circuit for the oscillator. The screen is bypassed to ground through C196, which offers low reactance at the operating frequency. Feedback to sustain oscillation is obtained primarily through the plate-to-grid capacitance of the tube. Because of the thorough screening, however, additional feedback is needed to insure oscillation. This is provided by C197 connected between the plate and control grid of V115. When the plate tank circuit is tuned to a frequency slightly higher than the natural frequency of the crystal, the feedback through C197 excites the grid circuit, and the crystal oscillates at approximately its natural frequency.

c. Piezoelectricity. A small plate cut in the proper way from a quartz crystal and placed between two conducting electrodes, will be mechanically strained when the electrodes are connected to a source of voltage. Conversely, if the crystal is compressed between two electrodes, a voltage will develop between the electrodes.

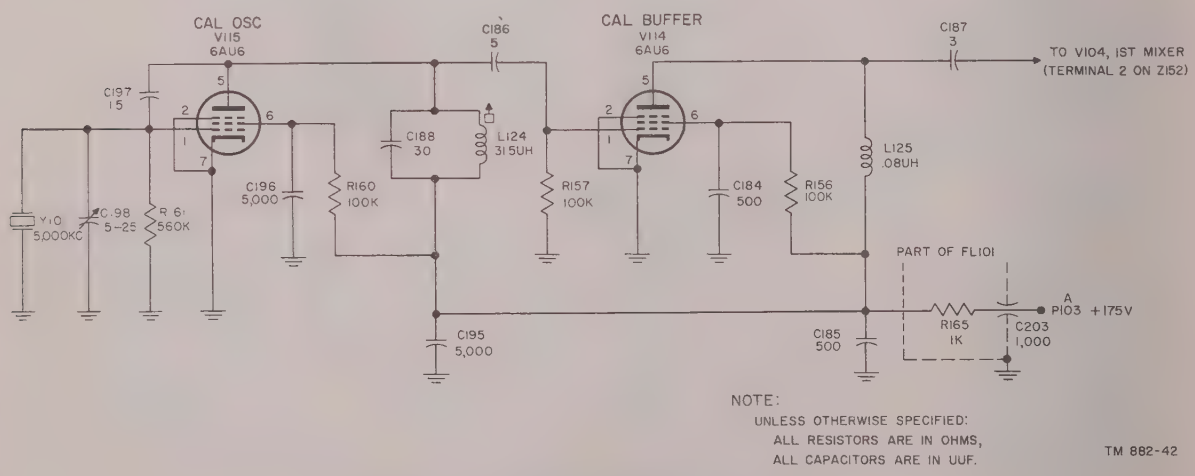


Figure 39. Calibrator oscillator and buffer.

Piezoelectric crystals can be used to transform electrical energy into mechanical energy and vice versa. When an alternating potential is applied to the crystal, the vibration or oscillation of the crystal will consist of two components; a forced oscillation at the frequency of the applied emf, and a free oscillation at the natural frequency of the crystal. Because of the piezoelectric effect, the crystal can be coupled to an electrical circuit and made to substitute for a coil-and-capacitor resonant circuit.

d. Crystal Circuit Equivalents (fig. 40). The crystal plate is held between a pair of electrodes commonly known as a crystal holder. The electrical coupling to the crystal is through the electrodes between which it is sandwiched; these electrodes form, with the crystal as the dielectric, a small capacitor. The crystal itself, without its holder, is equivalent to an extremely large inductance, L, in series with a correspondingly small capacitance, C, together with a relatively small series resistance, R. This results in a very high Q. These electrical equivalents of the mechanical properties of a crystal are shown in figure 40 as L, C, and R. The combined shunt capacitance of the holder electrodes, connecting leads, tube capacities and reflected plate impedance, is represented by C_h in figure 40. C_h is combined, in figure 39, with the phasing capacitor C198. The electrode capacitance is so large compared with the series capacitance of the crystal that it has only a small effect on the series-resonant frequency. It has a great effect, however, on the parallel-resonant frequency. At a critical frequency determined by the values of L and C, the reactance will cancel out and the impedance will be equal to R. At this point, the characteristics of the crystal itself are those of a series-resonant circuit. This is known as the series-resonant or natural frequency of the crystal. At a slightly higher frequency than this, the effective reactance of L and C combined will be inductive, and equal to the reactance of C_h. Under these conditions, the crystal has the characteristics of a parallel-resonant circuit. The frequency at which either of these conditions occur is the operating frequency to which the crystal is ground (when it is used to control the frequency of a vacuum tube oscillator). Whether the parallel-resonant or the series-resonant type of crystal is used depends on the type of oscillator circuit in which the crystal is employed.

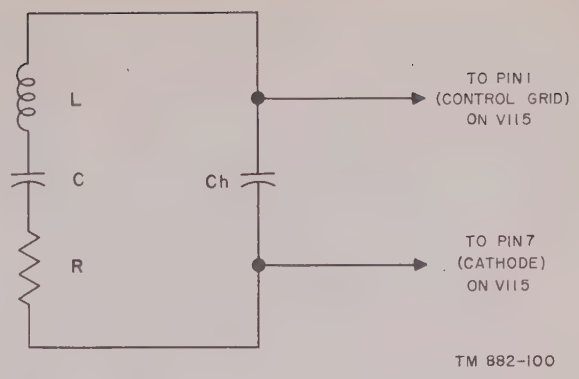


Figure 40. Electrical equivalents of piezoelectric crystal.

e. Circuit Description. When plate voltage is applied to the circuit, and the tube is conducting, an alternating potential is applied across the crystal through the feed-back coupling between the plate and grid circuits. Then, owing to its piezoelectric properties, the crystal is set into vibration. The voltage fed back is relatively weak, but since it is applied at the natural frequency of the crystal, it causes a free oscillation of the crystal at a much greater amplitude. The alternating potential developed by the free oscillation of the crystal is then applied between the grid and cathode of the tube. This energy serves to compensate for the losses in the plate circuit, similar to the flywheel effect in the ordinary noncrystal oscillator, and the circuit is kept in constant oscillation. The oscillator output is coupled through C186 to the control grid of the buffer, V114. R157 is the grid-leak bias resistor and C184 is the screen bypass capacitor. L125 is an r-f choke which serves as a plate load for V114 and isolates the r-f in the plate circuit from the power supply. The output from the buffer is coupled by C187 to the first mixer coupling link. B+ from pin A on P103 is decoupled by R165 and bypassed by C185, C195, and C203. R156 and R160 are screen grid voltage dropping resistors.

65. First Mixer

(figs. 41 and 42)

a. General. The first mixer stage uses a pentode, V104, operating into the first i-f transformer, T101. Cathode injection is employed for the first hfo signal, while the control grid is used for injection of signals from the r-f amplifier or from the calibrator buffer.

b. Purpose. The incoming signal is detected and its frequency reduced in the mixer, resulting in a new signal frequency known as the first i-f. The first i-f results from combining the signal frequency with the output from the first hfo to produce a *difference* frequency. Three higher frequencies are also present in the mixer output but they are rejected by means of selective circuits. These unwanted frequencies consist of the two original frequencies and the sum of these two.

c. Mixer Operation (fig. 41). In mixer operation, two signals, A and B, are injected simultaneously (one on the control grid and one on the cathode). Signal A represents the incoming signal and signal B represents the oscillator signal. Each of these signals is amplified and appears at the output of V104. A mixing action also takes place in the tube, resulting in two additional frequencies at the output of V104. If the receiver is tuned to 25 mc, signal A will be 25 mc and signal B will be 18.9058 mc. The chart below lists examples of frequencies A, B, A+B, and A—B for one frequency in each of the seven bands.

Freq. A (mc) R-f signal input	Freq. B (mc) Osc. signal	Freq. A+B (mc)	Freq. A—B (mc) Intermediate freq.
25 (band 1)	18.9058	43.9058	6.0942
35 (band 2)	26.3631	61.3631	8.6369
50 (band 3)	37.8116	87.8116	12.1884
65 (band 4)	47.7262	112.7262	17.2738
95 (band 5)	70.6233	165.6233	24.3767
130 (band 6)	95.4524	225.4524	34.5476
200 (band 7)	151.2465	351.2465	48.7535

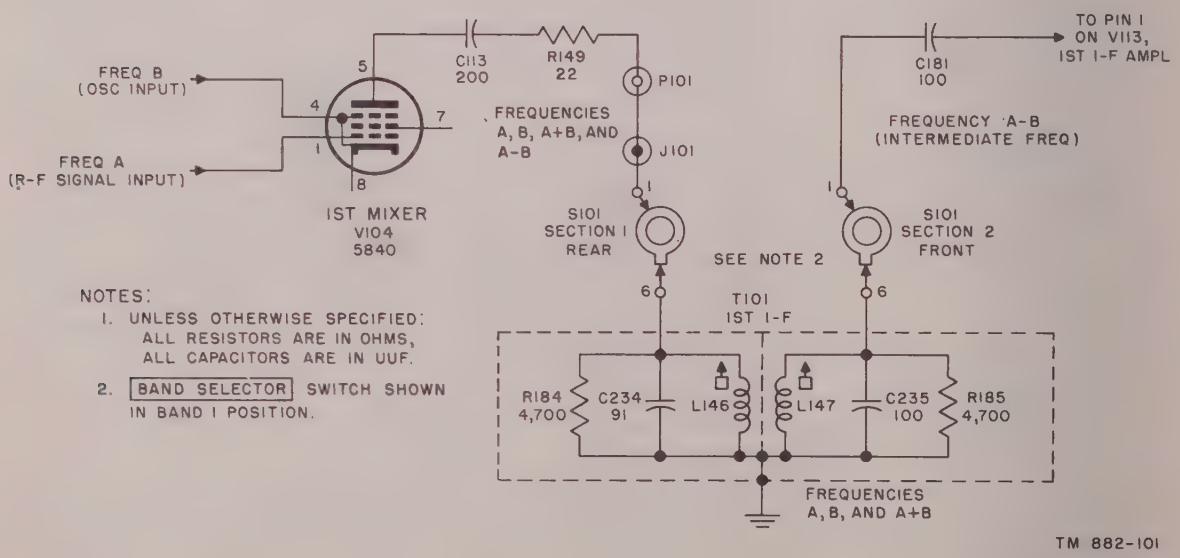


Figure 41. Mixer operation, simplified schematic.

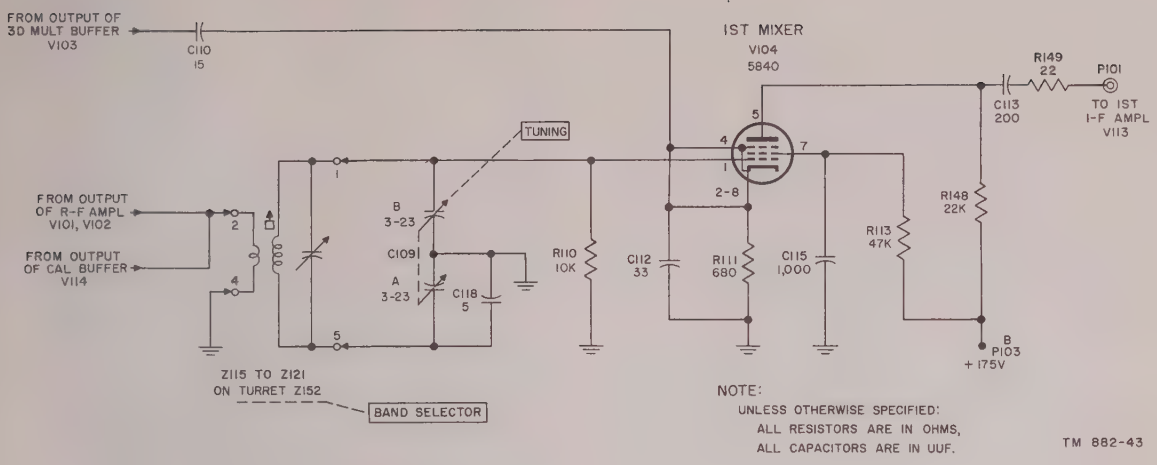


Figure 42. First mixer.

One of these is the sum of A and B (43.9058 mc) ; the other is the difference between A and B (6.0942 mc). Thus, four distinct frequencies are present at the output of the mixer tube. The only frequency desired in this case is the difference frequency. This is the lowest of the four, and it is separated from the other frequencies by means of tuned output circuit T101. The tuned circuit offers a high impedance to signals at the difference frequency (first i-f). The unwanted voltages appearing in the plate circuit are bypassed to ground. The i-f tuned circuit offers low impedance to these unwanted frequencies, shown in figure 41 as frequencies A (25 mc), B (18.9058 mc), and A+B (43.9058 mc).

d. Circuit Description (fig. 42). The signal originating in the first hfo, after being multiplied and amplified, is injected into the cathode from the third multiplier buffer. C110 in conjunction with C112 forms a capacitive voltage divider for this signal. This signal is mixed either with the received signal from the r-f amplifier (for signal reception), or with the signal from the calibrator buffer (for receiver calibration). The r-f amplifier output and the calibrator buffer output are both connected to the link on turret Z152 but only one of these two outputs is in operation at any one time. Whichever output is being used is eventually mixed in the tube with the signal from the third multiplier buffer, which is always present in the mixer when the receiver is being operated. The grid tank consists of the impedance on turret Z152 in parallel with the ganged tuning capacitors C109A and C109B and the padding capacitor C118 across C109A, which balances the input capacity of V104. Z152 is made up of seven impedances, Z115 through Z121 each consisting of a slug-adjusted inductance in parallel with a trimmer capacitor. Z120 and Z121 have a small fixed capacitor in addition to the trimmer capacitor. The proper combination is chosen by the BAND SELECTOR switch on the front panel, and C109A and C109B are tuned by the TUNING control on the front panel. The output from the grid tank appears across R110, connected from the tank to ground, and is directly coupled to the control grid of V104, where it is mixed with the first hfo signal from the cathode. The mixer output is coupled through C113 and R149 to the first i-f stage by means of P101 and J101. R149 is a parasitic suppressor resistor. The i-f transformer is permanently tuned to the difference frequency output from the mixer and this is the only frequency amplified in the first i-f stage.

e. Voltage Supply. B+ is supplied to the plate of V104 from pin B on P103 through R148 and to the screen grid through R113. C115 is an r-f bypass capacitor for the screen grid. The cathode bias resistor is R111.

66. First I-f Amplifier

(fig. 43)

a. General. The first i-f amplifier uses a remote cutoff pentode, V113, operated as a single-ended, class A, r-f amplifier. The high plate resistance of this type of tube has least effect on the selectivity of the amplifier, and the high mutual conductance provides the necessary gain. Gain control voltage is applied to the grid of the amplifier. For maximum selectivity and image rejection, double-tuned i-f transformers are used for interstage coupling.

b. Purpose. The i-f amplifier provides necessary gain, selectivity, and image rejection. After the incoming signal has been converted to the much lower intermediate frequency, separate i-f frequencies and transformers are employed on each band for best image rejection. Since they are operated at frequencies far removed from the signal frequency, these amplifier frequencies are not affected by the incoming signal.

c. Intermediate Frequencies. While three mixer stages are used in Radio Receiver R–220/URR to provide triple conversion, there are actually only two fixed i-f's as in the ordinary double superheterodyne. The first conversion results in seven different intermediate frequencies, the second conversion results in the 1.75 mc i-f, and the third conversion results in the 455 kc i-f. The 1.75 mc i-f is used for image rejection; the 455 kc i-f for gain and selectivity.

d. Gain Control and Bias. The gain of the stage is reduced by applying a negative voltage to the control grid from the gain control circuits through terminal D on J102 (fig. 43). The voltage increases the bias on the tube and reduces the mutual conductance and hence the gain. The control-grid voltage is determined by the gain control circuits in the main unit, connected through grid resistor R154 and mgc-agc decoupling resistor R152. C182 is the mgc-agc decoupling capacitor. R153 is the cathode bias resistor and C180 is the cathode r-f bypass capacitor. On bands 5, 6, and 7, R153 and C180 are shorted out through section 2 of S101 so higher gain can be obtained on these bands by means of the control-grid voltage alone.

e. Circuit Description. A male input jack, J101, connects with female plug P101 to receive the signal from the first mixer, which is applied to the primary of i-f transformer T101. The secondary of T101 is coupled by C181 to the control grid of V113. There are seven potted sections in T101, one for each band, selected by S101 (which is ganged to the BAND SELECTOR) (par. 83). Each section is permeability tuned by means of adjustable slugs in both primary and secondary. Coupling from V113 to the second mixer circuit is through C177.

f. Voltage Supply. The first i-f amplifier, second mixer, and second hfo stages are housed in a separate section of the r-f chassis, indicated in figure 123 as the second mixer section. This

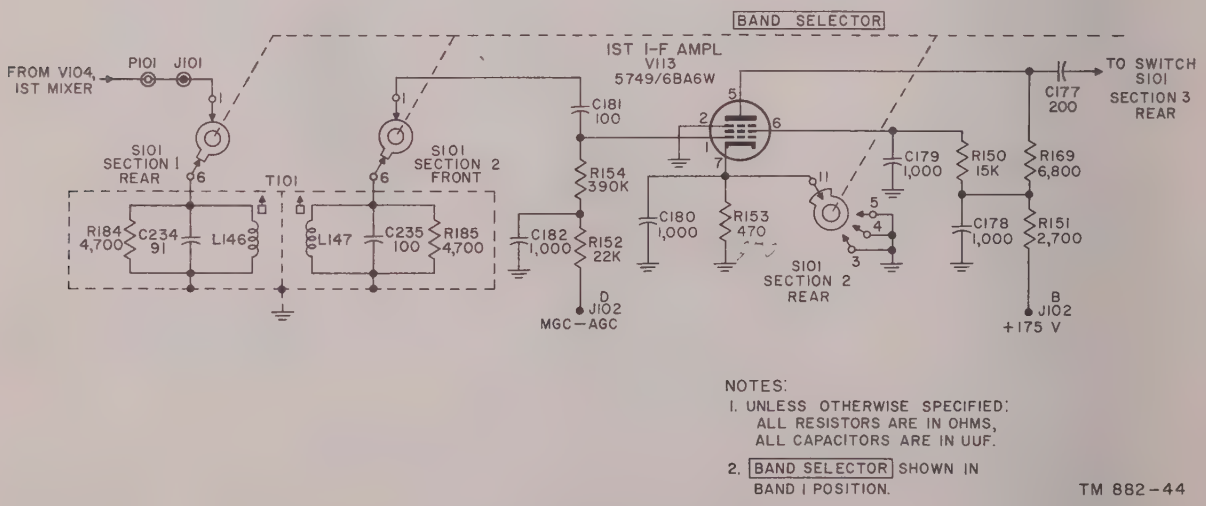


Figure 43. First i-f amplifier.

section is interconnected with the r-f unit by plugs and jacks. Main power jack J105 on the r-f unit connects directly with female plug P102, which is in turn connected to male jack J102 on the second mixer section (par. 55). There are four connections on J102, filament voltage for tubes V111, V112, and V113, gain control voltage for tube V113, B+ voltage, and ground. B+ is supplied to the plate and screen grid of V113 through B+ decoupling resistor R151, which helps prevent unwanted interstage coupling. C178 and C179 are r-f bypass capacitors. R169 is the plate load resistor and R150 is the screen grid voltage dropping resistor.

67. Second H-f Oscillator and Second Mixer

(figs. 44, 45, and 46)

a. General. The output from the first mixer passes through T101 to the first i-f amplifier and combines in the second mixer with the signal output from the second high frequency oscillator to produce a fixed i-f of 1.75 mc, which leaves the second mixer section through the female jack J106 and continues through a coaxial cable to J307 on the main unit of the receiver. Quartz crystals are used for frequency control of the second hfo and, since the selectivity of an i-f amplifier is proportional to the number of tuned circuits, the output from the first i-f amplifier plate is conducted through a second tuned circuit (T102) before entering the second mixer.

b. Second Mixer Input and Switching Circuits. Second mixer V112 uses a miniature sharp cutoff pentode with the signal voltage applied to the control grid and the oscillator injection applied to the cathode. Crystal oscillator V111 is also a pentode, with its cathode and suppressor grid grounded.

(1) *Input to second mixer stage.* The signal from the first i-f amplifier is induced in the i-f transformer T102, selected by sections 3 and 4 of switch S101 ganged to the BAND SELECTOR. The transformer secondary is directly coupled to the control grid of V112 through section 4 of S101. R147 is the cathode bias resistor. C174 (in conjunction with C183) forms a capacitive voltage divider for the signal from the second hfo, V111.

(2) *Band switching and crystal selection.* Separate input and output i-f transformers (T101 and T102) are provided for each of the seven bands. The primaries and secondaries are slug-adjusted, with a capacitor in shunt with each winding. A shunt resistor is also connected across T101 and T102 on all bands except 6 and 7. All seven i-f transformers are pretuned and potted. When a particular transformer is selected by the BAND SELECTOR switch, the corresponding crystal is also selected and all other

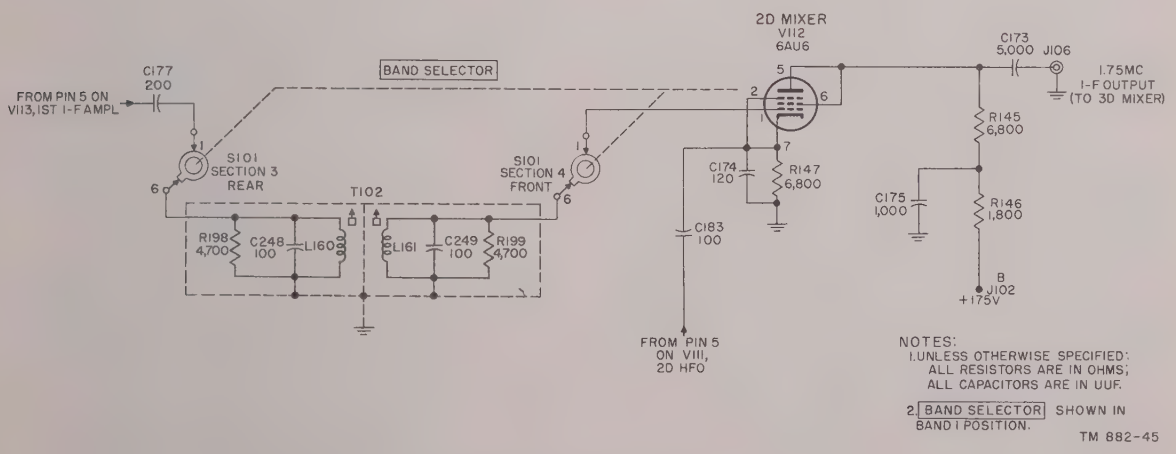


Figure 44. Second mixer.

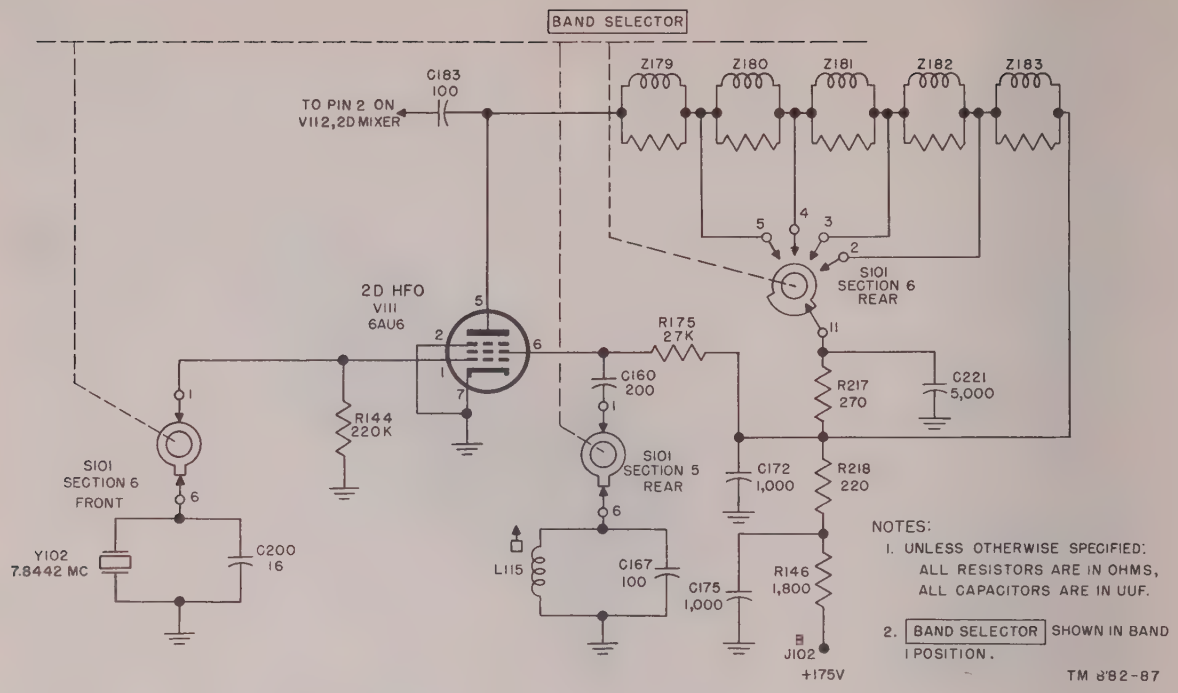


Figure 45. Crystal oscillator on band 1, simplified schematic.

crystal circuits are grounded. Grounding of unused tanks and crystals is accomplished by section 5, front, of switch S101 (fig. 132). This is done to prevent the tanks from causing interaction between circuits by adding resonant points through capacitive and magnetic coupling.

c. Second H-f Oscillator Operation. The cathode, control grid, and screen grid of V111 operate as a triode oscillator, the screen grid serving as anode. Electrons constituting the screen current sustain oscillation, while the remainder of the electron stream continues on to the plate and the plate load to form the output. The anode of the triode portion of V111 is thus electron-coupled (through the common electron stream between cathode and screen grid) to the output circuit by means of the plate, and from the plate circuit to the cathode of the second mixer, V112. Crystal oscillator circuits are used with V111 on bands 1, 2, and 3, while crystal resonator circuits are used with V111 on bands 4, 5, 6, and 7.

(1) *Bands 1, 2, and 3* (fig. 45). On bands 1, 2, and 3, the second high frequency oscillator constitutes what is known as a Miller circuit, oscillating at the parallel resonant frequency of the crystal. The L, C, and R of the crystal (Y102) are shunted by C200 which masks the capacity of the crystal holder. R144 limits the crystal current and provides operating bias. The parallel combination acts like the grid tank of a conventional tuned-plate tuned-grid oscillator; the *plate* circuit consists of L115 and C167. Feedback is through the interelectrode capacity of the tube. C160 is a plate blocking capacitor and C183 is the coupling capacitor to the second mixer stage. B+ is applied to the plate of V111 through the plate impedances (Z179 through Z183) and to the screen grid through the voltage dropping resistor R175. C175 is an r-f bypass capacitor used with R146 for decoupling. Additional decoupling is provided by R218 and C172. C221 is an r-f bypass capacitor.

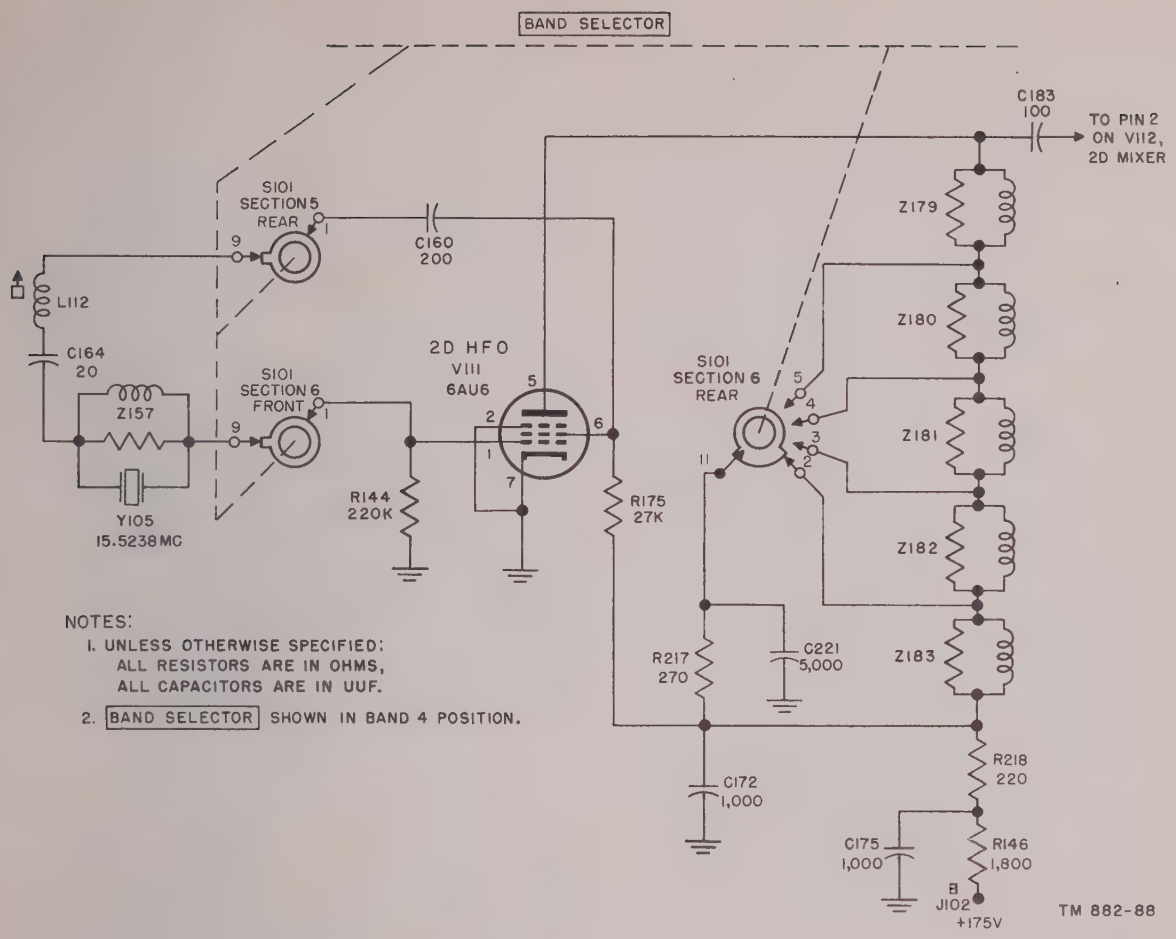


Figure 46. Second hfo.

(2) *Bands 4, 5, 6, and 7* (fig. 46). On bands 4, 5, 6, and 7, the circuit differs considerably from that on bands 1, 2, and 3. Coupling to the second mixer is the same, and the functions of R175, R144, and the plate impedances (Z179 through Z183), remain unchanged, but here the crystal oscillates at its natural or series-resonant frequency. On band 4 the inductance of Z157 cancels the capacitance of the crystal and holder and damps any tendency of the crystal to operate in a spurious mode. The shunt resistance of Z157 further aids the damping action. The series resonant circuit consisting of C164 and L112 acts as a selective feedback path allowing feedback to occur only in the vicinity of the desired oscillation. The crystal determines the exact frequency at which oscillation will occur. Z183 through Z180 are progressively shunted by R217 on bands 4 through 7 to provide the proper plate load impedance.

d. Second Mixer Operation and Output Circuit (fig. 44). The output of the crystal circuit which is chosen is applied to the second mixer cathode and beats with the signal from the first i-f amplifier.

(1) *Second mixer operation.* One of the two signals injected into the second mixer tube goes to the cathode from the second high frequency oscillator. The other signal, which is applied to the control grid of the second mixer,

comes from the output of i-f transformer T102. B+ from pin B on J102 is applied to both V111 and V112 through the isolating resistor R146, decoupled by C175. R145 is the load resistor for the V112 plate and screen grid, which are connected together.

(2) *1.75 mc output to third mixer.* The output from the plate of the second mixer is the two original frequencies and the sum and difference frequencies. This output is capacity coupled to the main unit components by C173, through J106. The difference frequency which is always 1.75 mc is selected by a 1.75 mc band pass filter (FL301) and the other frequency components are effectively grounded.

68. Third Mixer and 2205-kc Oscillator

(fig. 47)

a. General. The third mixer, V301, is a miniature type, sharp cutoff pentode with suppressor grid and cathode connected, control-grid injection being used for both input frequencies. The same type tube is used for the 2205-kc oscillator, which employs a crystal in a Pierce circuit for maximum stability. Both the input and the output of the third mixer are filtered for greater selectivity.

b. Purpose. To obtain high gain and selectivity at an intermediate frequency of 455 kc, the 1.75-mc output from the second mixer is applied to the third mixer. There the 1.75-mc signal is beat with the output of the 2205-kc oscillator. A difference frequency of 455 kc is thus obtained for the i-f amplifiers which follow.

c. 2205-kc Crystal Oscillator. In the Pierce circuit, the feedback is supplied by the direct coupling between plate and grid circuits provided by the crystal which is connected between these two elements. This effectively represents a coil and capacitor in series and the d-c plate voltage cannot be impressed on the grid. C302 is the plate-to-grid d-c blocking capacitor. The crystal operates as a series-resonant circuit, permitting only the crystal frequency r-f current to reach the grid (par. 67*c* (2)). The crystal may be considered as replacing the tank inductance of a self-excited Colpitts oscillator (par. 60). The cathode and suppressor grid are grounded, and grid leak bias is provided by R301. No tuned circuits are required in the Pierce oscillator, the constant frequency output of 2205 kc is determined by crystal Y301.

d. 1.75-mc Filter. FL301 is a band-pass filter with a center frequency of 1.75 mc and a 6-db bandwidth of 200 kc. The filter is used to increase the selectivity of the receiver. Input and output jacks J307 and J308, mounted at opposite ends of the hermetically-sealed filter case,

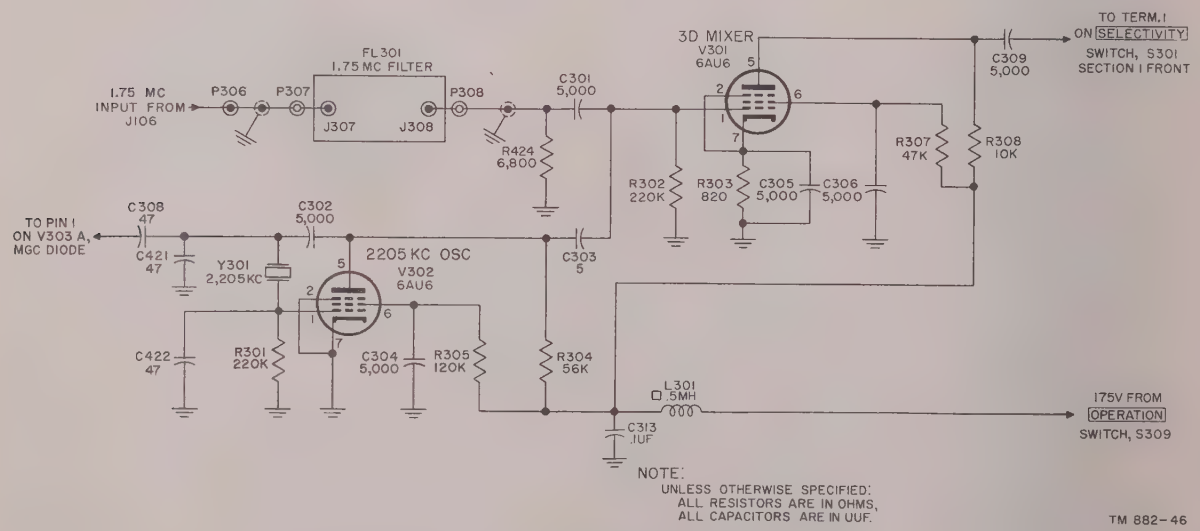


Figure 47. 2205-kc oscillator and third mixer.

are connected to the second and third mixers, respectively, through coaxial cables. FL301 is replaceable as a unit and requires no adjustment.

e. Circuit Description. The 1.75-mc signal from the r-f unit enters the main unit through a coaxial cable. One end of the cable, P306, connects with J106 in the r-f unit; the other end, P307, connects with J307 in the main unit. J307 is the input connection to the 1.75-mc filter, FL301. The output from the filter, which appears across R424, is coupled through C301 to the control grid of the third mixer, V301. R302 is the grid return resistor and R303 the cathode bias resistor for V301. The suppressor and cathode of V301 are interconnected and bypassed through C305. The output of the 2205-kc oscillator, V302, is coupled to the control grid of V301 through C303. (See paragraph 65*c* for mixer operation.) The 455-kc output from the third mixer is coupled through C309 and section 1 of the SELECTIVITY switch, S301, to one of the 455-kc filters.

f. Voltage Supply. B+ for both V301 and V302 is filtered by L301 and C313. Plate load resistors are R308 for V301 and R304 for V302. Screen grid voltage dropping resistors are R307 and R305 for V301 and V302, respectively. The screen grid of V301 is bypassed for r-f by C306, and V302 by C304.

g. Manual Gain Control Voltage. Voltage for manual gain control is obtained from the 2205-kc oscillator at the junction of Y301 and C302, and coupled by C308 to the mgc diode, V303.

69. 455-kc Selectivity Filters and 455-kc I-f Strip

(figs. 48, 49, and 50)

a. General. Before final detection takes place, further amplification is provided for the relatively weak 455-kc signal from the third mixer, V301. The third mixer output is capacity coupled through a selectivity filter to four cascaded 455-kc i-f amplifiers and thence capacity cou-

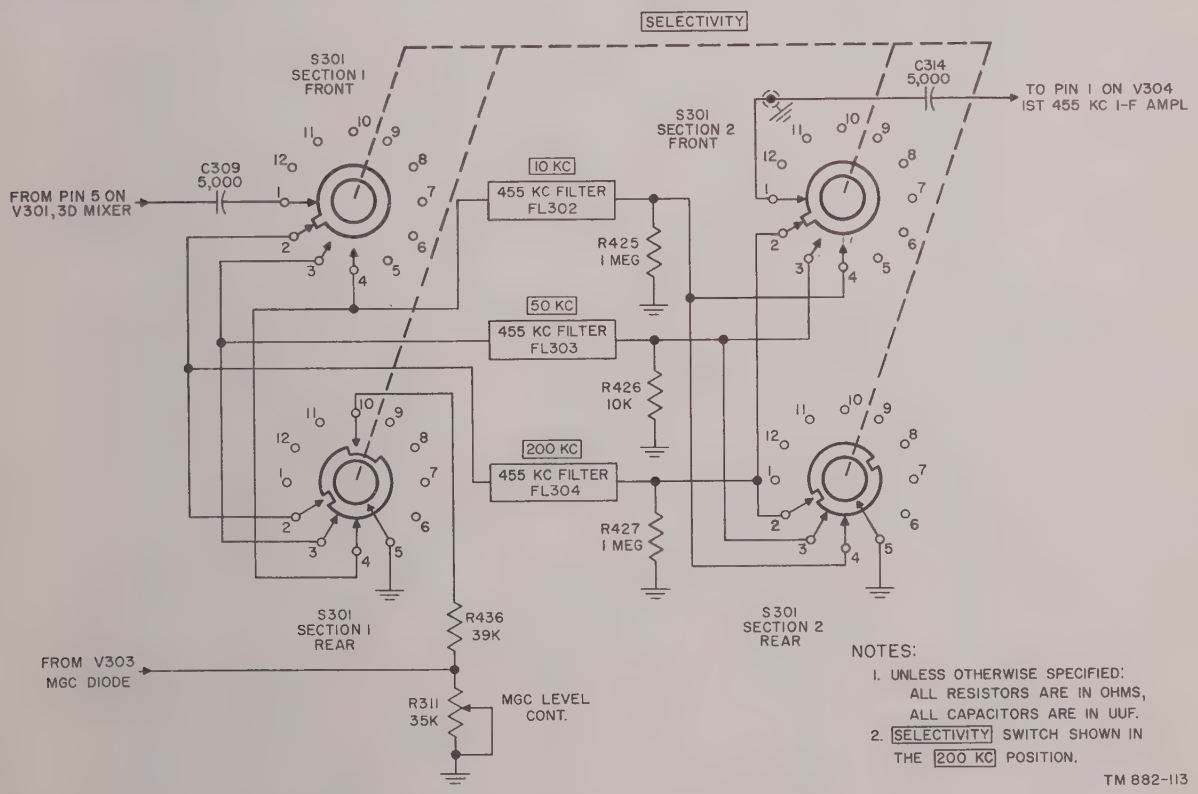


Figure 48. 455-kc selectivity filters.

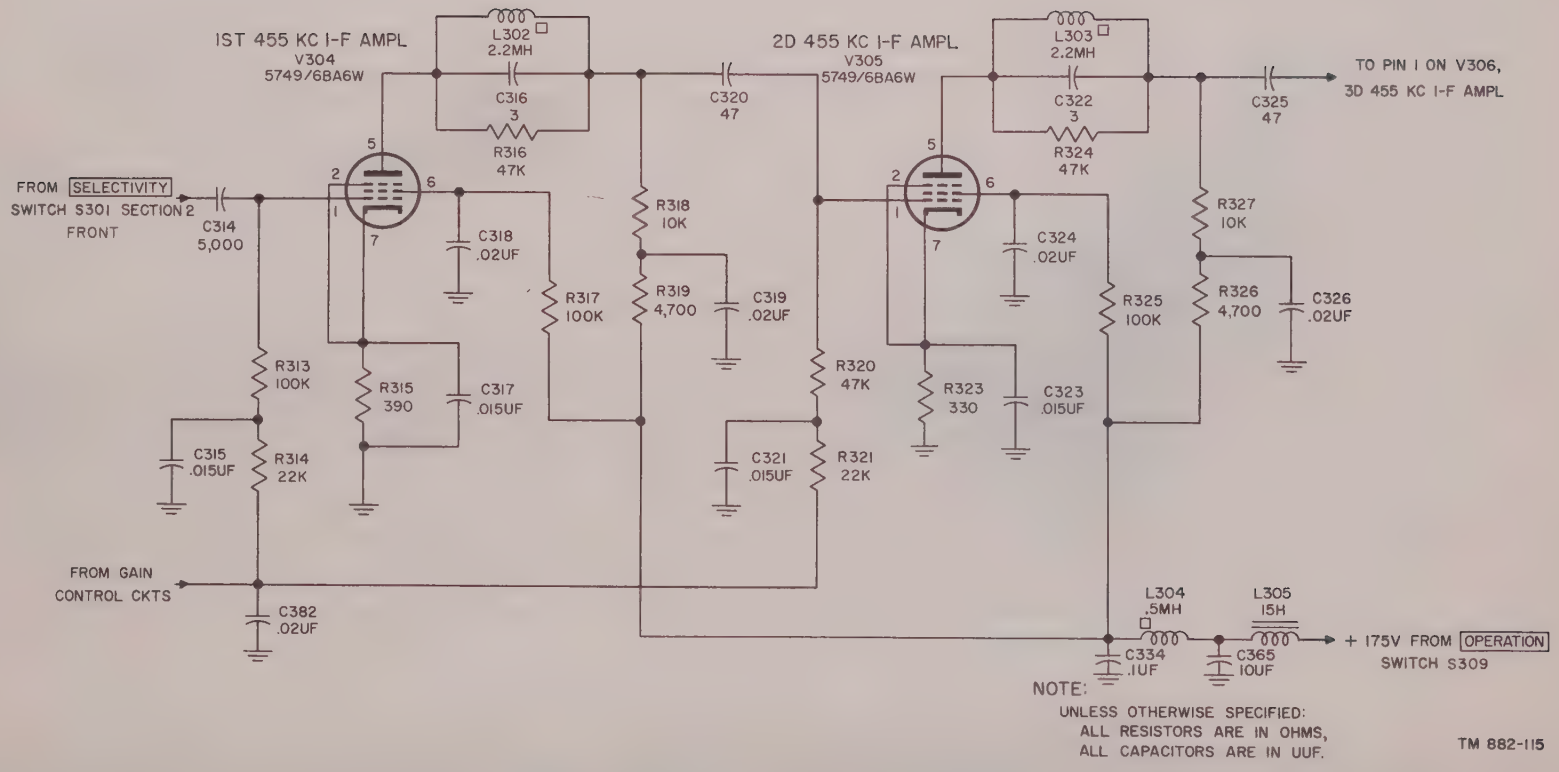


Figure 49. First and second 455-kc i-f amplifiers.

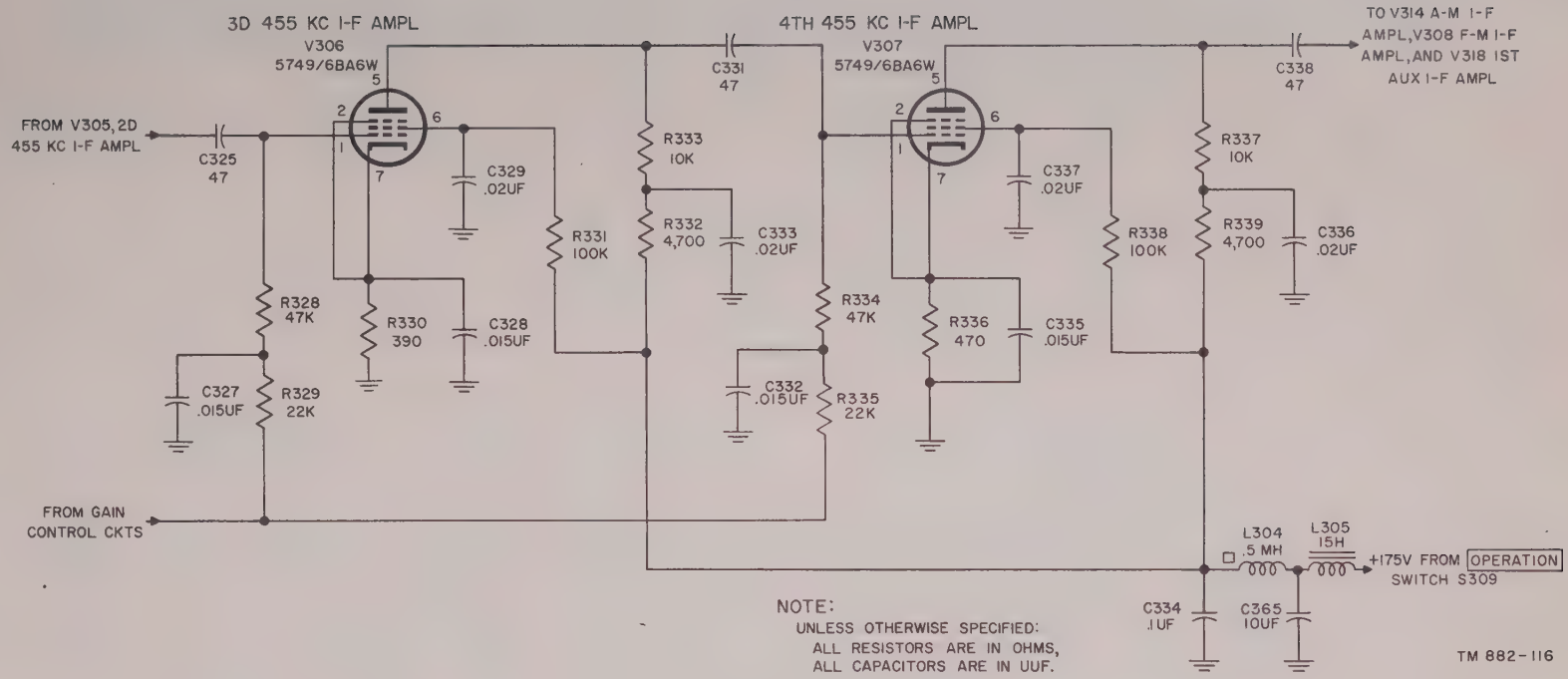


Figure 50. Third and fourth 455-kc i-f amplifiers.

pled to the a-m, f-m, and auxiliary circuits. The four amplifiers constituting the 455-kc i-f strip operate generally the same as the first i-f amplifier, V113 (par. 66), except that differences in frequency and signal level require different values for component parts; the values of some of these component parts determine the gain in the later stages.

b. 455-kc Filters (fig. 48). A means of varying the selectivity of the receiver is provided by the 455-kc filters, which consist of three independent filter circuits, FL302, FL303, and FL304, with bandwidths of 10 kc, 50 kc, and 200 kc, respectively. The desired bandwidth of the signal is chosen by the front panel SELECTIVITY switch, S301, the first section being connected to the filter input and the second section to the output. The first section, rear, of S301 serves to ground the input to the filter circuits not in use. The output circuits of the unused filters are grounded by the second section, rear, of S301. The output of each filter is loaded by a resistor (R425, R426, and R427) and capacity coupled by C314 to the grid of the first 455-kc i-f amplifier, V304.

c. First and Second 455-kc I-f Amplifiers (fig. 49). The grid bias of V304 and V305 is determined by the negative voltage from the gain control circuits which is applied through grid load resistors R313 and R320. The V304 resistor, R313, presents a relatively high impedance to the incoming signal to provide maximum voltage gain in the first 455-kc i-f stage; succeeding stages employ lower grid impedances. The mgc-agc decoupling network consists of R314 and C315 for V304, R321 and C321 for V305, with C382 serving as a common mgc-agc line filter. The output circuit of V304 contains a trap consisting of L302, C316, and R316, connected in parallel, which offers maximum impedance at 1.75 mc and 2205 kc to prevent interference from the second mixer and 2205-kc oscillator. The V305 plate circuit uses a similar trap, consisting of L303, C322, and R324. The cathode of V304 is biased and bypassed by R315 and C317, respectively. The cathode bias of V305 consists of R323, bypassed by C323. V304 is coupled to the grid of V305 by means of C320, and the output from V305 is coupled to the grid of the third 455-kc i-f amplifier by means of C325.

d. Third and Fourth 455-kc I-f Amplifiers. (fig. 50). From V305, the signal passes through the third and fourth 455-kc i-f amplifiers, V306 and V307, to the f-m, a-m, and auxiliary circuits. Coupling capacitors between these stages are C325, C331, and C338. The cathode of V306 is biased and bypassed by R330 and C328, respectively, and the V307 cathode is likewise biased and bypassed by R336 and C335. Grid resistors are R328 for V306 and R334 for V307. The mgc-agc decoupling network consists of R329 and C327 for V306, and R335 and C332 for V307.

e. Voltage Supply. Operating voltage for the plates and screen grids of all four 455-kc i-f amplifiers is supplied through OPERATION switch S309, and L305. C365 is a B+ line filter capacitor. C334 is a B+ filter capacitor and L304 is a B+ filter choke for the 455-kc i-f strip. The power supply decoupling networks consist of R319 and C319 for V304, R326 and C326 for V305, R332 and C333 for V306, and R339 and C336 for V307. Plate load resistors are R318 for V304, R327 for V305, R333 for V306, and R337 for V307. Screen grid voltage dropping resistors are R317 for V304, R325 for V305, R331 for V306, and R338 for V307. Screen grid bypass capacitors are C318 for V304, C324 for V305, C329 for V306, and C337 for V307.

70. A-m I-f Amplifier

(fig. 51)

The signal from V307, the fourth 455-kc i-f amplifier, is coupled through C338 to the control grid of V314, the a-m i-f amplifier. V314 provides further i-f amplification and also serves to isolate the a-m circuit from load changes taking place in the auxiliary circuit when both circuits are used simultaneously. The operation of the circuit is similar to that of V307, the fourth 455-kc i-f amplifier. Voltage from the gain control circuits is applied to grid return resistor R368 through the decoupling network composed of R367 and C366. R369 provides cathode bias and is bypassed by C367. The output of V314 is fed to the a-m detector, V315A, through C369. B+ for the plate and screen grid is obtained through the OPERATION switch, S309. R371 is the plate load resistor, R370 is the screen grid voltage dropping resistor, and C368 is an r-f bypass capacitor for the screen grid circuit.

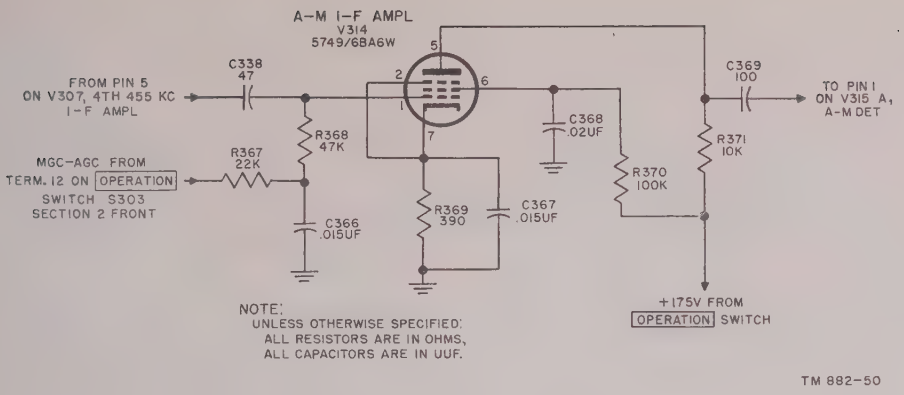


Figure 51. A-m i-f amplifier.

71. A-m Detector, Noise Suppressor, and Noise Limiter

(fig. 52)

a. General. The functions of a-m detector and noise suppressor are combined in one tube, V315A and B, the A section serving as a diode detector and the B section acting as a shunt-type noise suppressor, which is switched into the circuit by the NOISE LIMITER switch, S302. Noise peaks are clipped by the noise suppressor, which conducts only above a predetermined signal level. The level of the signal to be suppressed is adjusted by the front panel NOISE LIMITER control, R380, which is ganged to S302. When the noise is of sufficient amplitude and duration, V315B will conduct and the noise pulses are clipped.

b. Description of Circuits. The a-m detector is used for the reception of either c-w, mcw or voice transmissions. The noise suppressor circuit is most effective when receiving voice transmissions. The bfo (par. 72) must be used to receive c-w transmissions.

(1) *A-m detector.* The 455-kc signal from V314 is coupled through C369 to the cathode of the diode detector, V315A. For c-w reception, the output from the bfo, V321, is also applied at this point. The use of two coupling capacitors, C410 and C371, at opposite ends of the shielded coupling cable, reduces the capacitive loading effect of the cable on either stage. The diode detector rectifies the 455-kc signal; this rectified voltage is negative with re-

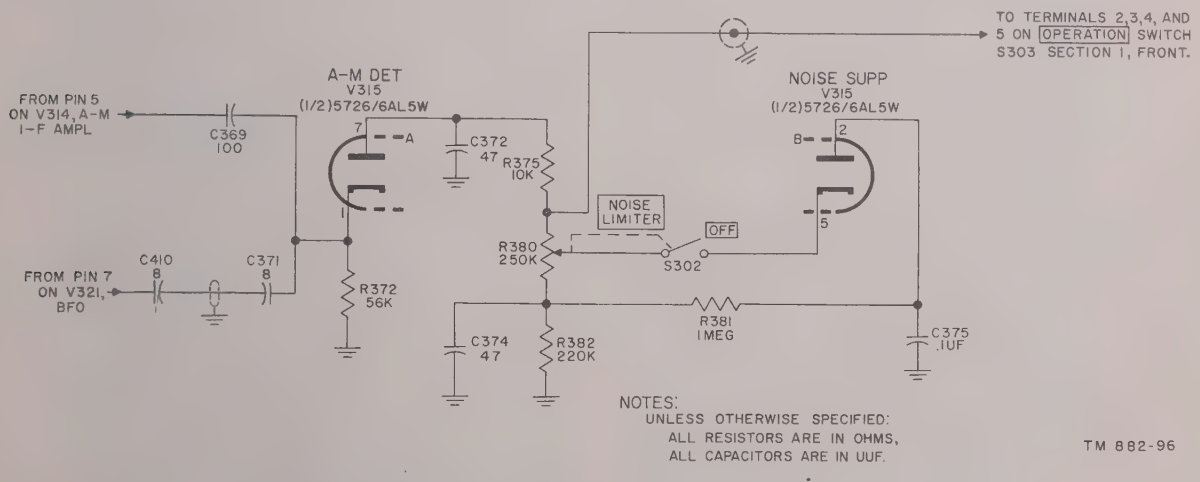


Figure 52. A-m detector and noise suppressor.

spect to ground. The rectified voltage, which varies with the amplitude of the r-f signal and appears across R375, R380, and R382, is relatively free from r-f, due to the bypass capacitors, C372 and C374. The audio signal output is taken from the junction of R375 and R380 and applied through the OPERATION switch to the first audio amplifier.

(2) *Noise suppressor.* When the front panel NOISE LIMITER switch, S302, is closed, the noise suppressor tube, V315B, is placed in operation. The plate becomes negative but the cathode becomes more negative (both with respect to ground). Under these conditions, V315B conducts. This action charges C375 to a potential essentially equal to that of the cathode and the tube no longer conducts. A negative voltage proportional to the carrier level is developed across C375, and this voltage cannot change rapidly because of the large time constant provided by C375, R381, and R382. The noise suppressor is normally inactive or non-conducting due to the negative charge put on its plate by C375, remaining inactive until the negative voltage on its cathode exceeds the negative voltage on its anode. This condition arises when noise peaks exceeding the maximum carrier modulation level drive the cathode negative (instantaneously). This has the effect of driving the anode positive instantaneously and the tube will conduct, lowering the resistance load of the detector. With an effectively lower detector load, less signal is delivered to the audio amplifier.

(3) *Noise limiter.* The NOISE LIMITER control, R380, is adjusted to the level of the incoming signal by regulating the amount of bias on the cathode of V315B. The algebraic sum of the voltage across R380 and C375 determines the amount of impedance between the audio output and ground. As the contact arm approaches the junction of R380 and R382, decreasing the bias, the suppressor action is likewise decreased, this position being useful when receiving weak signals. As the contact arm is moved in the opposite direction, the noise suppressor action is increased, a useful condition when receiving strong signals.

72. Beat Frequency Oscillator
(fig. 53)

a. General. C-w signals are made audible by heterodyning them with a beat signal at the a-m detector. A series-tuned Colpitts oscillator generates the beat frequency when its plate circuit is closed by the B.F. OSCILLATOR switch, S306, which is ganged to the pitch control, C409, and operated from the front panel. The bfo output, taken from the cathode, is coupled through C410 and C371 to the cathode of the a-m detector, where it beats or mixes with the c-w signal to make the latter audible.

b. Circuit Description. V321 is a sharp cutoff pentode chosen for its high mutual conductance. It is used with a high-Q coil, L309, to raise the permissible ratio of the voltage-divider capacitances; a high ratio is desirable for best stability. This voltage-divider network consists of four capacitors, C412, C413, C407, and C409, from grid to cathode to ground. Capacitors C407 and C409 are shunt connected and may be considered as a single capacitor; C409 is controlled by a fine adjustment to vary the pitch by shifting the resonant frequency slightly. A 1:3 ratio is obtained between this equivalent capacitance and either C412 or C413 (which are equal). The tank circuit is composed of L309, C405, and C408, connected from grid to ground. C408, accessible from the bottom of the main chassis, is used to adjust the tank to resonate at a center frequency equal to the i-f, 455 kc. The Q of the tank circuit is kept high by tapping the tube across only a small portion of the oscillating tank circuit, resulting in very loose coupling between tube and circuit. Taps are provided between the series capacitors shunted across the coil. With the tube capacitances shunted by large capacitors, the effects of changes in supply voltage and loading are reduced. The resulting tank circuit has a high L/C ratio and, therefore, the tank current is much lower than in the circuits using high-C tanks. This greatly reduces drift, thus main-

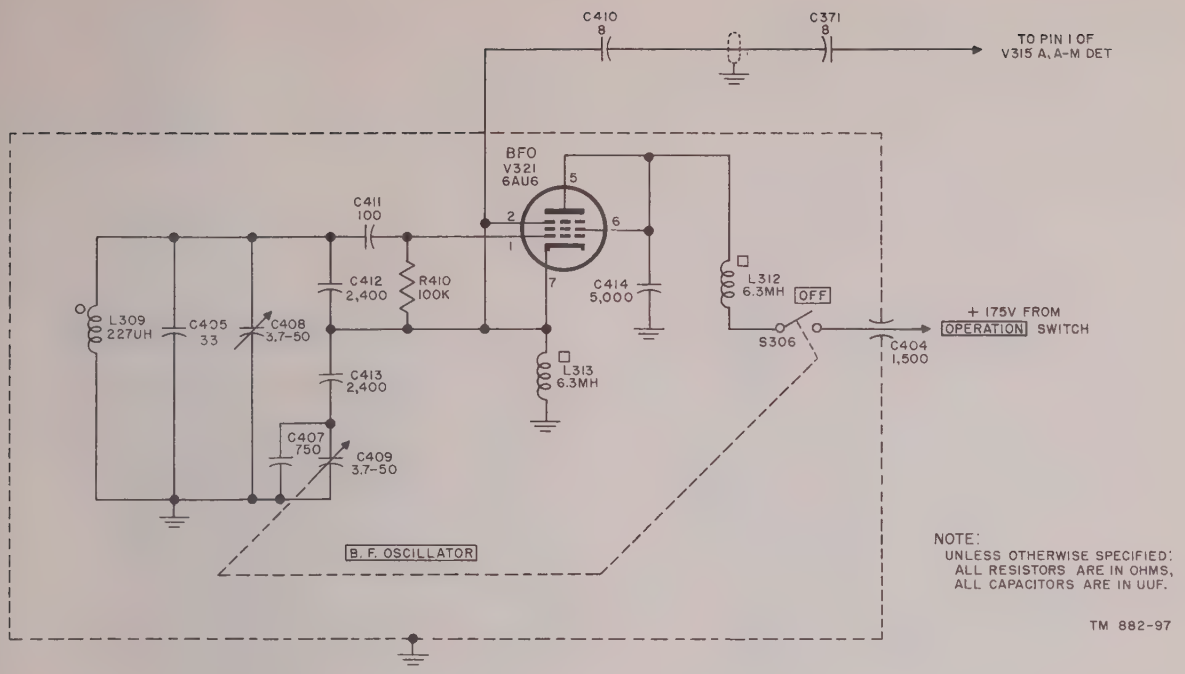


Figure 53. Beat frequency oscillator.

taining the pitch of the c-w signal relatively constant during reception. C411 couples the tank to the control grid and R410 is the grid return resistor.

c. Harmonic Prevention. The bfo is carefully shielded to prevent coupling to any part of the receiver except the a-m detector and to prevent its harmonics from getting into the front end and being amplified along with the desired signals.

(1) *Shielding.* The entire bfo is housed in a shielded can, grounded to the chassis. A feed-through capacitor, C404, bypasses r-f at the point where the plate and screen voltage connection is made through the can. The bfo output is conducted to the a-m detector by means of a shielded cable.

(2) *Voltage supply.* Plate and screen voltage for the bfo is obtained through OPERATION switch S309 and B.F. OSCILLATOR switch S306. The plate and screen grid are tied together and the tube is triode operated, C414 serving as r-f bypass for both plate and screen. R-f is kept out of the power supply by r-f choke L312. The cathode r-f choke, L313, offers a high impedance to the a-c from the plate circuit.

73. F-m I-f Amplifier and F-m Limiter Stages

(fig. 54)

a. F-m I-f Amplifier. The function of this stage is to isolate the f-m circuit from load changes taking place in the auxiliary circuit when both circuits are operated simultaneously. Agc voltage is also obtained from this stage. The circuit is similar to that of V307, the fourth 455-kc i-f amplifier, except that a sharp-cutoff pentode is used to drive the first limiter, V309, and this requires different values for the component parts. The signal from V307 is fed to the control grid of the f-m i-f amplifier through an additional coupling capacitor, C339, which also isolates the V308 grid from the gain control voltage applied to V314 (fig. 132). R340 is the V308 grid resistor. The cathode bias resistor, R341, is bypassed by C340. In addition to its isolating function, the f-m i-f amplifier provides the following outputs:

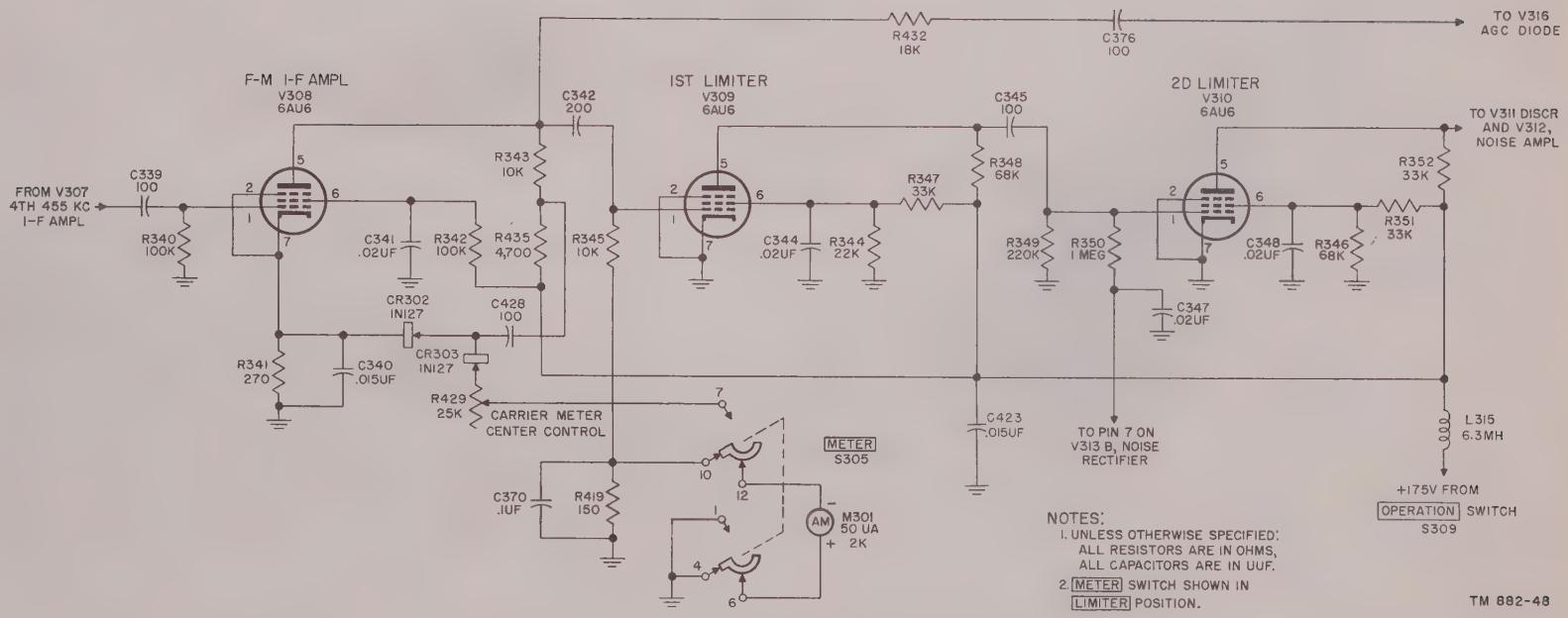


Figure 54. F-m i-f amplifier and f-m limiters.

(1) From the plate, through R432 and C376, to the agc diode, furnishing excitation voltage for the agc circuit which develops a bias voltage proportional to the average strength of the carrier.

(2) From the plate, through C342, furnishing excitation voltage to drive first limiter V309.

b. F-m Limiter Stages. The final i-f stages in the f-m branch of Radio Receiver R–220/URR are known as *limiters* and differ slightly in circuit arrangement from the preceding i-f amplifying stages (fig. 48).

(1) *General.* Two limiter stages, V309 and V310, are used to reduce the amplitude variations of the input signal. To effect limiter action, the two tubes are operated between cutoff and saturation. The plate circuits are RC (resistance-capacitance) coupled and the second limiter stage is coupled to discriminator V311 through C349 and C350. The amplitude of the limiter output remains practically constant for any increase in the amplitude of the limiter input above that required for limiting action. Therefore, the voltage fed to the discriminator will be of constant amplitude for all signal voltages above the limiting threshold.

(2) *Purpose.* The limiters provide a constant-level signal for application to the discriminator. Since the signal being fed into the limiters is not of constant amplitude, limiter action is required to overcome these variations in signal amplitude which are developed in the i-f amplifier as a result of the nonuniform selectivity characteristics of the various i-f stages (as well as a-m noise). The primary purpose of the limiter is to remove all amplitude variations present in the output of the f-m i-f amplifier system and to pass on to the discriminator a signal having varying frequency but constant amplitude. Although employed primarily for this purpose, the limiter also provides a certain amount of gain.

(3) *Circuit description.* The limiter tube acts as an amplifier which is easily driven to saturation or to cutoff; that is, plate-current saturation is produced during a portion of one half of the signal cycle and plate-current cutoff is brought about during a portion of the other half of the cycle. The required operating conditions result from the use of a sharp cutoff tube with comparatively low values of screen and plate voltage and little or no initial control-grid bias, so that the tube overloads very easily and plate-current cutoff is quickly reached. Under the proper conditions, signals of comparatively small amplitude will swing the grid voltage into those zones causing either plate-current cutoff or plate-current saturation, thereby limiting the magnitude of signal plate-current variations in the plate circuit. The limiter tube has no effect on the frequency of the signal.

(a) First limiter. The output of the f-m i-f stage appears across grid return resistor R345 and is applied to the grid of V309. The suppressor grid and cathode are grounded. The output from the plate is coupled to the grid of the second limiter by C345.

(b) Second limiter. The action of the second limiter is similar to that of the first limiter. The use of two limiters assures positive limiting. In the event that weak signals do not have noise amplitude variations eliminated in the first limiter they will be clipped by the second limiter. This is accomplished in the second limiter by using a higher value of grid resistor, R349, and by applying a higher value of plate voltage. The output is coupled through C349 and C350 to the discriminator stage (V311).

(4) *Metering and bias voltage.* Grid current in the first limiter is measured by connecting the meter across R419 through METER switch S305 in the LIMITER position. C370 is an a-f by-

pass capacitor. Bias voltage for noise rectifier V313B is obtained from the second limiter through R350. C347 is an a-f bypass capacitor.

(5) *Voltage supply.* B+ is obtained from the power supply through the OPERATION switch, S309, and applied to the plate of V308 through R343, and to the screen grid through R342. V309 receives plate voltage through R348 and screen voltage through R347. The screen voltage dropping resistor for V310 is R351 and the plate voltage for V310 is applied through R352. R344 and R346 are used to improve the screen voltage regulation on V309 and V310, respectively. Screen grid bypass capacitors are C341 for V308, C344 for V309, and C348 for V310. The B+ voltage is filtered by L315 and C423 before being applied to V308, V309, and V310.

74. Discriminator

(figs. 55 to 61)

a. General. The discriminator, V311, is a double-tuned type of f-m detector where one tuned circuit is peaked at a frequency below the carrier frequency and the other tuned circuit is peaked at a frequency above the carrier frequency. The discriminator operates at a center frequency of 455 kc. Operation results in a positive voltage when the applied frequency is lower than 455 kc, and a negative voltage when it is higher than 455 kc. This output voltage may be measured between terminal 6 on the OPERATION switch, S303 (section 1, front) and ground (chassis). V311 is a miniature, high perveance type of twin diode, the diodes being used in conjunction with each other.

b. Purpose. The basic function of the discriminator in the f-m branch of Radio Receiver R–220/URR is to convert the frequency-modulated i-f carrier into audio voltages of different

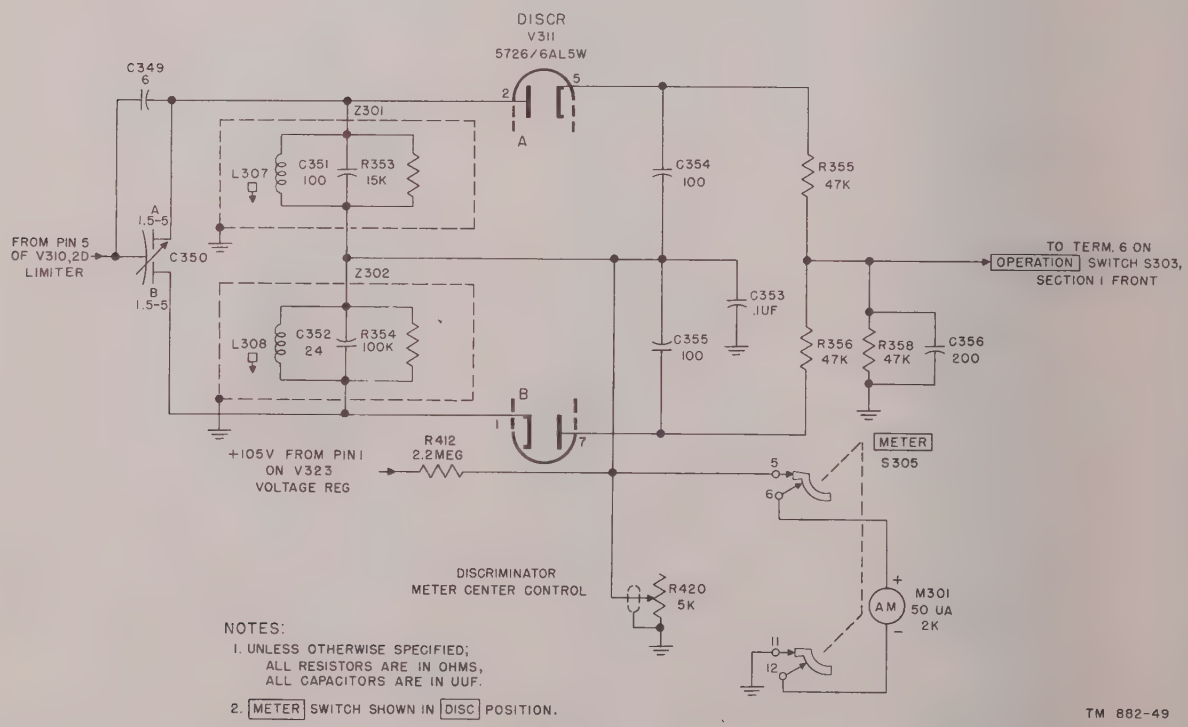


Figure 55. Discriminator.

amplitudes. In addition to this rectifying action, the discriminator provides a zone of operation on its straight, sloping characteristic wherein a uniform change in frequency results in a linear output provided that the frequency deviation does not exceed the linear portion of the discriminator characteristic curve.

c. Circuit Description (fig. 55). The two tuned circuits are Z301 tuned below the i-f, and Z302 tuned above the i-f; these circuits have no inductive coupling between them. Z301 consists of L307, C351, and R353 in parallel, with L307 slug-adjusted to peak at 355 kc. Z302 consists of L308, C352, and R354, with L308 slug-adjusted to peak at 555 kc. The resistors, R353 and R354, are used to equalize the Q of the tuned circuits, resulting in improved linearity of the output. The second limiter tube, V310, feeds a variable frequency voltage which is constant in amplitude over the frequency deviation range to l-f (low-frequency) circuit Z301. At the resonant frequency of Z301, the current will be minimum and the voltage maximum. This occurs at 355 kc. In the same manner, maximum voltage will appear across Z302 at its resonant frequency of 555 kc. Second limiter output to the high-frequency circuit, Z302, is obtained through C350B, and to the low-frequency circuit, Z301, through C350A and C349. The variable differential capacitor, C350, is adjusted so that the input applied to the two tuned circuits will be of the same amplitude. Each of the tuned circuits is conected to one-half of the diode rectifier, V311; Z301 is connected to the plate of V311A and Z302 is connected to the cathode of V311B. The voltage applied from the limiter to the diodes will cause them to conduct in direct proportion to the amplitude of the signal in their respective tuned circuits. When the plate of V311A (pin 2) is positive, it will conduct through Z301, placing a charge on C354. The time constants are large enough so that C354 holds its charge until the next positive half-cycle. In this manner, the a-c voltage applied to Z301 from the limiter is rectified. The same action takes place in V311B except that its cathode is connected to Z302, and therefore it will conduct only during the negative half-cycle of the signal into Z302. The two tubes are thus conducting on alternate half-cycles. The conduction path for V311B is from its cathode (pin 1) to its plate (pin 7), charging C355, through Z302, and back to its cathode. Again, the time constants are large enough so that C355 holds its charge until the next negative half-cycle.

d. Response Curves (fig. 56). Since the two tuned circuits Z301 and Z302 are peaked to different frequencies, their response to the frequencies from the limiter stage will be different. When the response of these two circuits is plotted in terms of frequency, as in figure 56, it is noted that only at one frequency, namely 455 kc, is the response of both circuits the same. At all other frequencies the response of Z301 is different from that of Z302, with the result that the magnitude of signal voltage fed to the two rectifiers for rectification depends upon the response of the circuit to the frequency of the signal voltage. An important point to remember is that at any one instant only one frequency exists in the system, and whether V311A or V311B or both will be rectifying the signal depends entirely upon the frequency of the signal voltage. Thus, if at any one instant the frequency of the signal is 355 kc, the circuit which responds to this frequency is Z301, and rectification will take place in V311A, the rectified voltage appearing across C354. This is true for all frequencies from F1 to F3. Between F3 and F5, both tubes are operating and a differential voltage is developed across C354 and C355. At exactly 455 kc (F4), the signal applied to each diode will be of the same amplitude, both diodes will conduct, and C354 and C355 are both charged to the same potential. This is the condition when there is no modulation. Between F5 and F7, only Z302 is responsive and the signal is being rectified in V311B, the rectified voltage appearing across C355. Again considering instantaneous conditions, when the frequency of the carrier goes up, due to modulation, the amplitude of the signal in Z302 will increase because of the response characteristics of Z302 as the signal approaches its resonant frequency. At the same time, the signal in Z301 will decrease because the signal frequency is farther away from the resonant frequency of Z301. This greater amplitude signal in Z302 will cause V311B to conduct more than it did when the signal frequency was 455 kc, and will charge C355 to a higher potential. At the same time, the weaker signal in Z301 will cause V311A to conduct less, and C354 will be charged

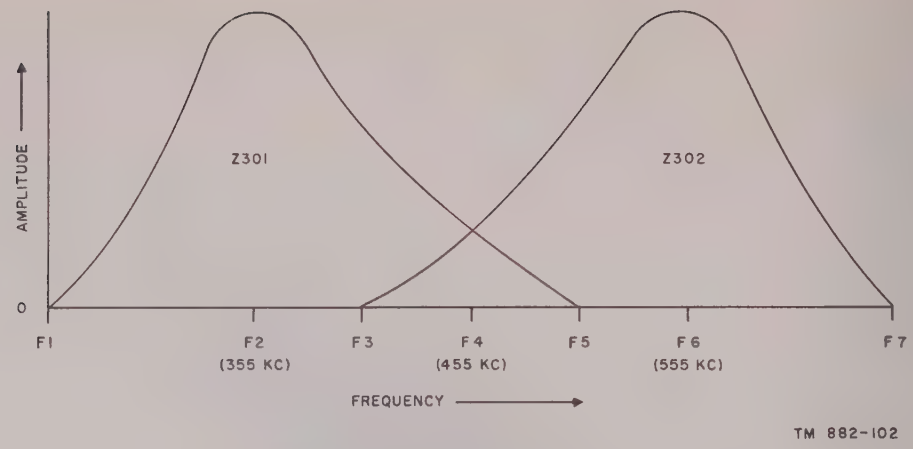


Figure 56. Signal voltage developed across Z301 and Z302.

to a lower potential. When the modulation causes the carrier frequency to go down, conditions reverse. The frequency of the carrier nears the resonant frequency of Z301, causing a greater amplitude signal to be applied to V311A and charging C354 to a higher potential. At the same time, the signal frequency is farther away from the resonant frequency of Z302, and a lower amplitude signal is applied to V311B, charging C355 to a lower potential. Because a frequency-modulated signal is constantly swinging above and below the "at rest" or center (zero modulation) frequency in accordance with the modulating frequency, it is seen that the potentials on C354 and C355 will also be changing at the rate of the modulating frequency.

e. Equivalent Circuits (figs. 57, 58, and 59). The two loads upon the rectifier sections V311A and V311B of the discriminator are arranged in a bridge circuit as shown in figure 57. Although each diode rectifier has its own load impedance, and the rectified voltage developed in each diode is present across the respective load impedances, resistor R358 and capacitor C356 are common to both diodes, and the discriminator output is taken from across this R-C combination, between the point A and ground (point D). As far as point A and ground are concerned, either can be positive or negative with respect to the other, depending upon the magnitude of the voltages across C354 and C355. If the two rectified voltages across C354 and C355 are equal, no current will flow in R358, and the voltage between ground and point A is zero. If that across C354 is greater than that across C355, the final voltage between ground and point A is equal to that across C354 minus that across the resistor, R355. If that across C355 is greater than that across its associated resistor, R356, then the final voltage across R358 is equal to that across C355 minus that across R356. As to the polarity of the voltage between ground and point A, that depends, too, upon which capacitor, C354 or C355, has the greater voltage across it. The nature of the output obtained from point A as a result of the variations in potentials of C354 and C355 can be understood more easily by referring to figures 57, 58, 59, 60 and 61.

(1) *At zero modulation* (fig. 57). For explanation purposes, nominal values are assumed for the potentials on C354 and C355. These potentials will be equal when the carrier frequency is at 455 kc, or zero modulation. Values of 2 volts will be assumed for each capacitor and the polarity will be as shown in figure 57. The difference of potential from point B to point C will then be 4 volts. Since resistors R355 and R356 are equal, the voltage at point A with respect to points B or C will be equal to one-half the voltage from point B to point C. This is always true, no matter what the potential is on C354 and C355. In this case, the voltage across R355 is 2 volts and the voltage across R356 is also 2 volts. The output voltage, taken from point

A to point D, is determined by Kirchhoff's voltage law (the algebraic sum of the voltages around a closed loop must be equal to zero). Thus, from point A to point B, there is plus 2 volts; point B to point D, there is minus 2 volts; then, since "plus 2 minus 2" is equal to zero, the unknown voltage from point D to point A must be zero. To check this, Kirchhoff's Law is applied to the other loop. From point A to point C there is minus 2 volts, from point C to point D there is plus 2 volts, and from point D to point A is unknown. Here again, "minus 2 plus 2" is equal to zero and the unknown, from point D to point A, is equal to zero. This is the desired condition, since the carrier frequency was at rest, or zero modulated to begin with.

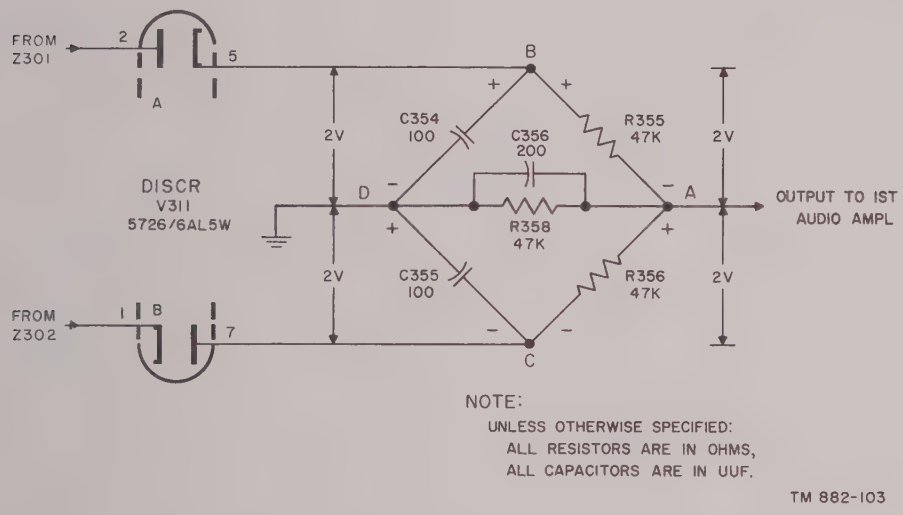


Figure 57. Equivalent circuit of discriminator at zero modulation.

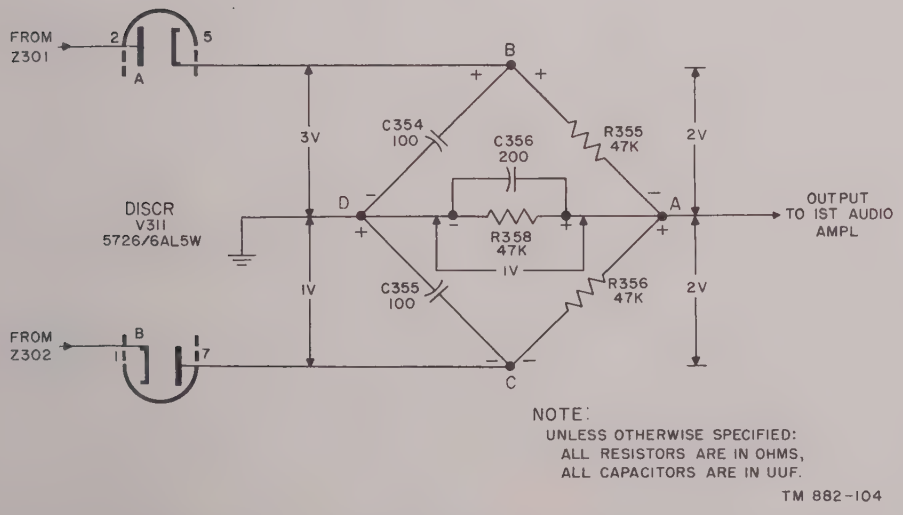


Figure 58. Equivalent circuit values in discriminator when carrier swings downward.

(2) *At positive alternation* (fig. 58). When the carrier swings downward in frequency, and C354 is charged to a higher potential, conditions will be as shown in figure 58. Here a value of 3 volts is assumed for the potential on C354 and 1 volt for C355. Since the potential difference from point B to point C is still 4 volts, the potential of point A with respect to point B or point C is still the same. However, the potential from point A to point D will have changed, and this can be determined by again applying Kirchhoff's Law. From point A to point B, there is 2 volts; from point B to point D there is minus 3 volts, and from point D to point A there must be "plus 1 volt" to make the sum of the loop equal to zero. Again checking by adding the voltage around the other loop, from point A to point C there is minus 2 volts; from point C to point D there is plus 1 volt, and the potential differences between point D and point A must be "plus 1 volt."

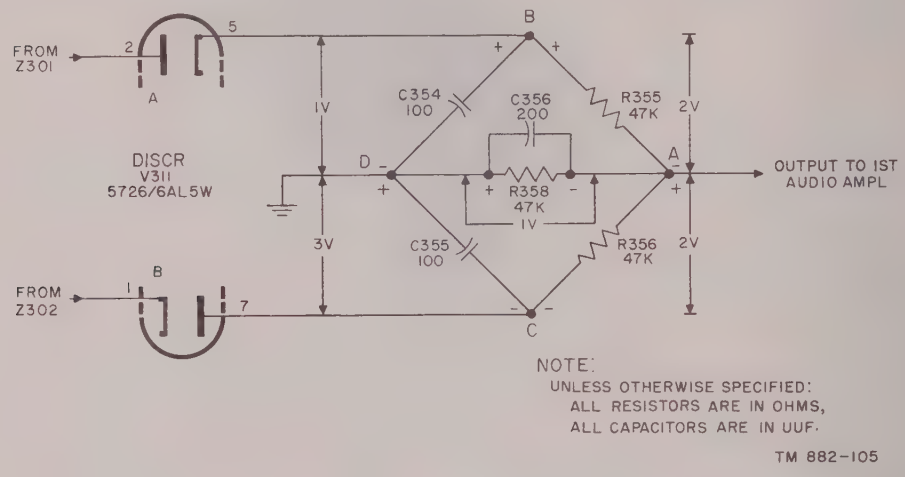


Figure 59. Equivalent circuit values in discriminator when carrier swings upward.

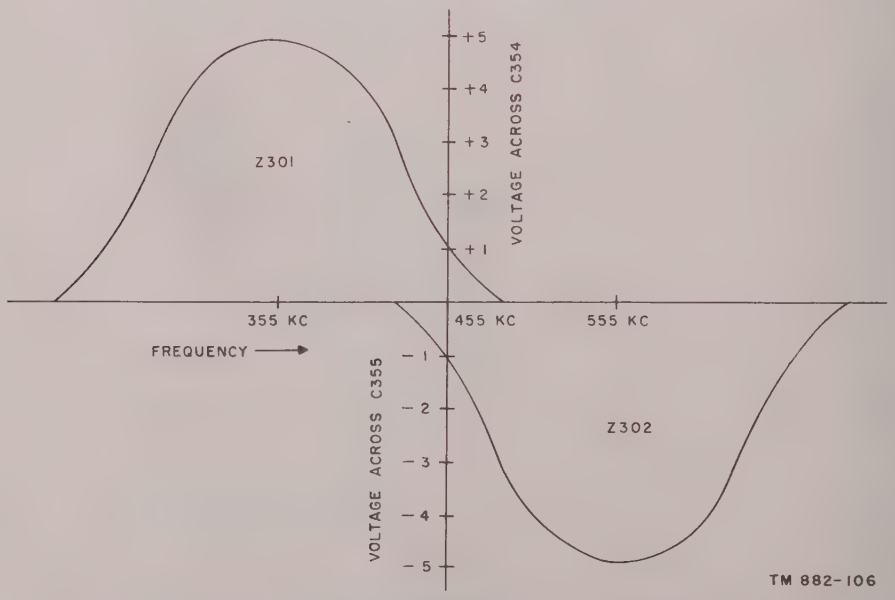


Figure 60. Typical d-c voltages developed across C354 and C355.

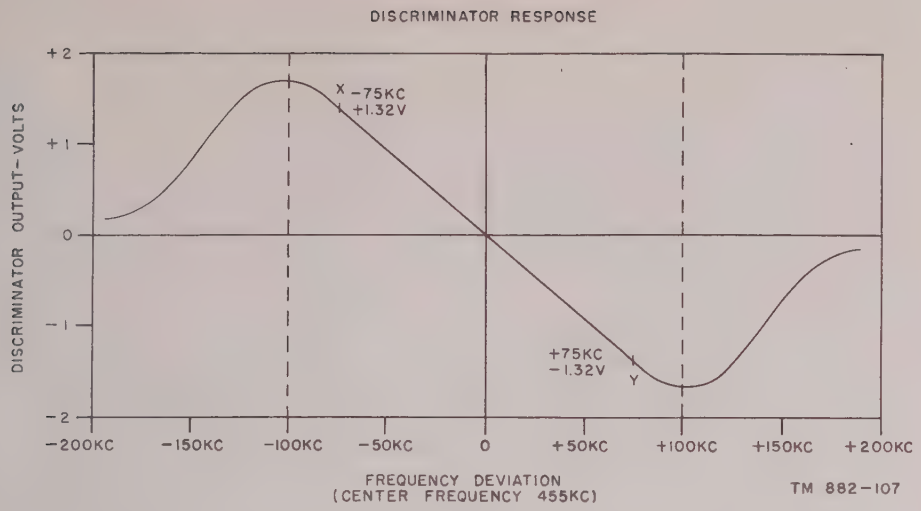


Figure 61. Over-all output of discriminator circuit showing linear portion between X and Y.

(3) *At negative alternation* (fig. 59). When the carrier swings upward in frequency, C355 is charged to the greater potential and C354 is charged to a lesser potential. By employing the same method as was used with a downward swing of the carrier, it can be shown that the voltage from point A to point D will now be of opposite polarity, or "minus 1 volt."

f. Combining Output From Both Diodes. It has been shown that when the input signal frequency is at the zero modulation position, there is no output from the discriminator.

(1) *Voltages across C354 and C355* (fig. 60). When the carrier swings downward in frequency, a positive voltage is produced, and when the carrier swings upward in frequency, a negative voltage is produced at point A with respect to point D (ground). If we now plot the output voltage across C354 and C355 respectively with respect to frequency, which means the response of Z301 and Z302 respectively, we secure a graph which looks like that shown in figure 60, nominal values again being assumed. The response of the Z301 system is shown above the frequency reference line because the voltage developed across output load R358 as a result of Z301 is positive with respect to ground. The response of the Z302 system is shown below the reference line because the voltage developed across R358 as a result of Z302 is negative with respect to ground.

(2) *Voltages across R358* (fig. 61). The two curves shown in figure 60 can be combined into the typical "S" characteristic of the discriminator by algebraically adding the voltages developed across C354 and C355 as shown in figure 61. For example, at the mean frequency of 455 kc, the response of Z301 is the same as that of Z302 and the voltage developed across C354 is the same as that across C355, but since they are of opposite polarity with reference to ground, they cancel and the net output voltage across R358 is zero. Other output values are developed in the same way. Since the carrier swings are in accordance with the original modulating audio frequency and the output of the discriminator is in accordance with the swings of the carrier frequency, the original modulating audio frequency is reproduced by the discriminator. Points X and Y show the maximum deviation limits on each side of the center frequency.

g. Application (fig. 55).

(1) Circuit balance is measured at the tank junction by the meter, M301. Regulated voltage is supplied to the meter through R412 and with no signal applied, the meter reads at DISC. CENTER. R420 on the rear apron of the main unit is adjusted to center the meter to this point.

(2) The de-emphasis network, across which the discriminator output is developed, consists of R358 and C356, connected between ground and the junction of R355 and R356. From this junction a connection is made through the OPERATION switch (FM SQUELCH position) to the first audio amplifier V317B.

75. Auxiliary Circuits

(figs. 62, 63, and 64)

a. First Auxiliary I-f Amplifier (fig. 62). The first auxiliary i-f amplifier, V318, isolates the a-m and f-m circuits from the auxiliary circuit. The signal from the fourth 455-kc i-f amplifier is coupled to the control grid of V318 through the common coupling capacitor, C338 (not shown on fig. 62), and the auxiliary circuit coupling capacitor, C391; the primary function of C391 is to separate the control grid of V318 from the control grid of the a-m i-f amplifier, V314. This permits simultaneous operation of the auxiliary circuit with either the f-m or the a-m circuit. B+ to V318 is supplied through R399 which, together with C395, constitutes a decoupling network. Agc voltage from V316 is developed across the resistor network consisting of R379, R433, and R434, with C379 and C400 functioning as agc decoupling capacitors. Part of this agc voltage is fed through R394 to the control grid of V318 from the junction of R433 and R434. R397 is a voltage dropping resistor for the screen grid. R398 is the plate load resistor and R396 is the cathode bias resistor. R-f bypass capacitors are C393 for the cathode and C394 for the screen grid. In addition to its isolating function, the first auxiliary i-f amplifier provides the following outputs.

(1) From the plate, through C396 and C397, furnishing excitation to the second auxiliary i-f amplifier, V319.

(2) From the junction of R400 and R402 to the aux i-f output jack, J302, on the rear apron of the main chassis.

b. Second Auxiliary I-f Amplifier (fig. 63). The primary function of the second auxiliary i-f amplifier, V319, is to increase the gain. The 455-kc i-f signal from V318 is fed to the control grid of V319 and the output, amplified at the intermediate frequency, is coupled through C401 to the auxiliary diode, V320. Output is also taken from the cathode for the purpose of stabilizing the agc voltage developed by V316. The gain of the second auxiliary i-f amplifier is regulated by the agc voltage applied to the control grid through the grid resistor, R401. The function of the agc decoupling network is the same as for V318 (par. 75*a*). R406 is the plate load resistor, R404 is the cathode bias resistor, and

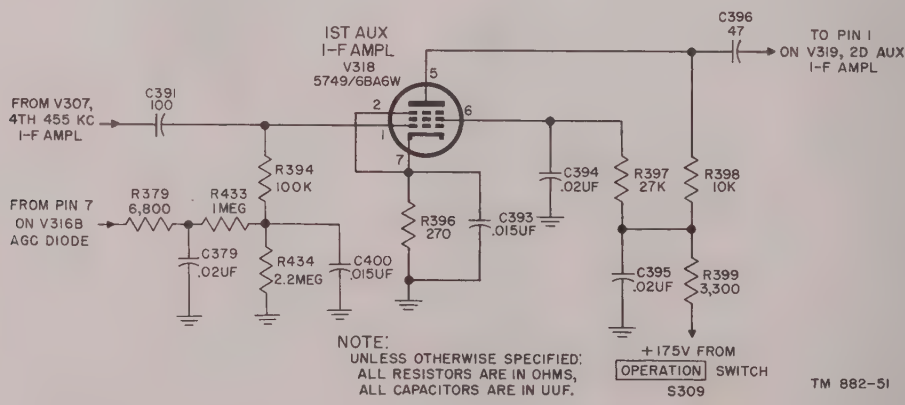


Figure 62. First auxiliary i-f amplifier.

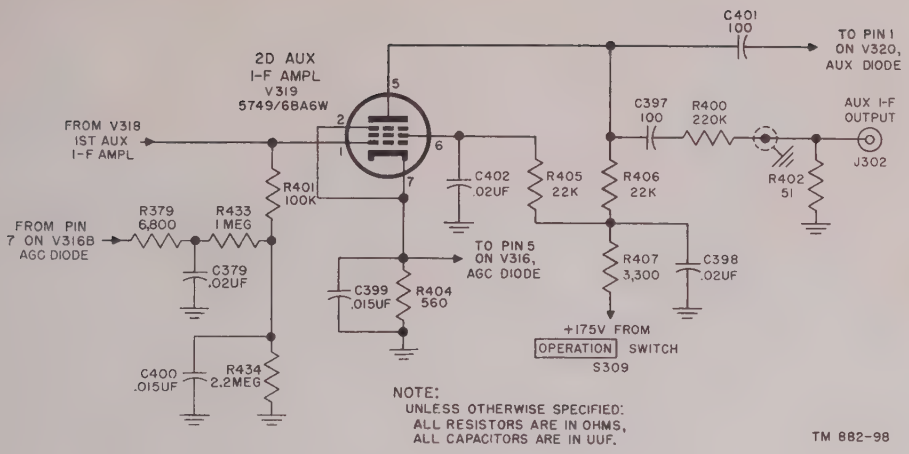


Figure 63. Second auxiliary i-f amplifier.

R405 is a voltage dropping resistor for the screen grid. R-f bypass capacitors are C399 for the cathode and C402 for the screen grid. Stage decoupling is provided by R407 and C398.

c. Auxiliary Diode (fig. 64). One-half of a twin diode, V320, is used as an auxiliary detector; connections are made between pins 1 and 7. The other half of the tube is not used. R408 is the auxiliary diode cathode resistor. (For detector operation, see par. 71). The signal from the second auxiliary i-f amplifier, V319, is coupled to V320 through C401 and the output voltage from V320 is developed across R409 and C403. The rectified output of approximately 5 volts is available at J301, the aux diode output jack on the rear apron of the main unit for an r-f signal input of approximately 2 uv (microvolts).

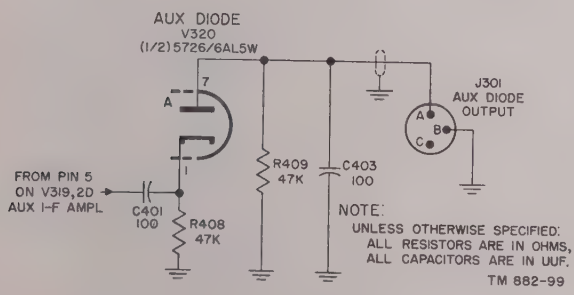


Figure 64. Auxiliary diode.

76. Squelch and First Audio Amplifier Circuits

(figs. 65 and 66)

a. General (fig. 65). The squelch circuit consists of the noise amplifier, V312, the noise rectifier, V313, the squelch section of V317, and portions of the grid and plate circuits of the second limiter, V310. A high-mu twin triode is used for V317, with the A section connected as the squelch tube and the B section as the first audio amplifier. V310 and V312 are sharp cutoff pentodes and V313 is a duo-diode.

b. Purpose and Use. The squelch circuit is used with the first audio amplifier to reduce the noise in the audio output when no signal is being received. In operation, noise from the second limiter, in the absence of signal, is fed to the noise amplifier, V312. The noise is amplified and fed to the noise rectifier, V313; this rectified noise voltage tends to bias the squelch tube, V317A, in a positive direction. At the same time, a negative voltage is taken from the second limiter control grid and fed to the squelch tube, which it tends to bias in a negative direction. The difference voltage thus developed and applied to the V317A grid ranges from approximately one-half volt positive (with no signal) to approximately 1.5 volts negative (when signals are present). When the bias is negative (1.5 volts or greater), the squelch tube is inoperative and the first audio amplifier, V317B, is functioning normally. When the bias is zero or positive, the squelch tube is operating

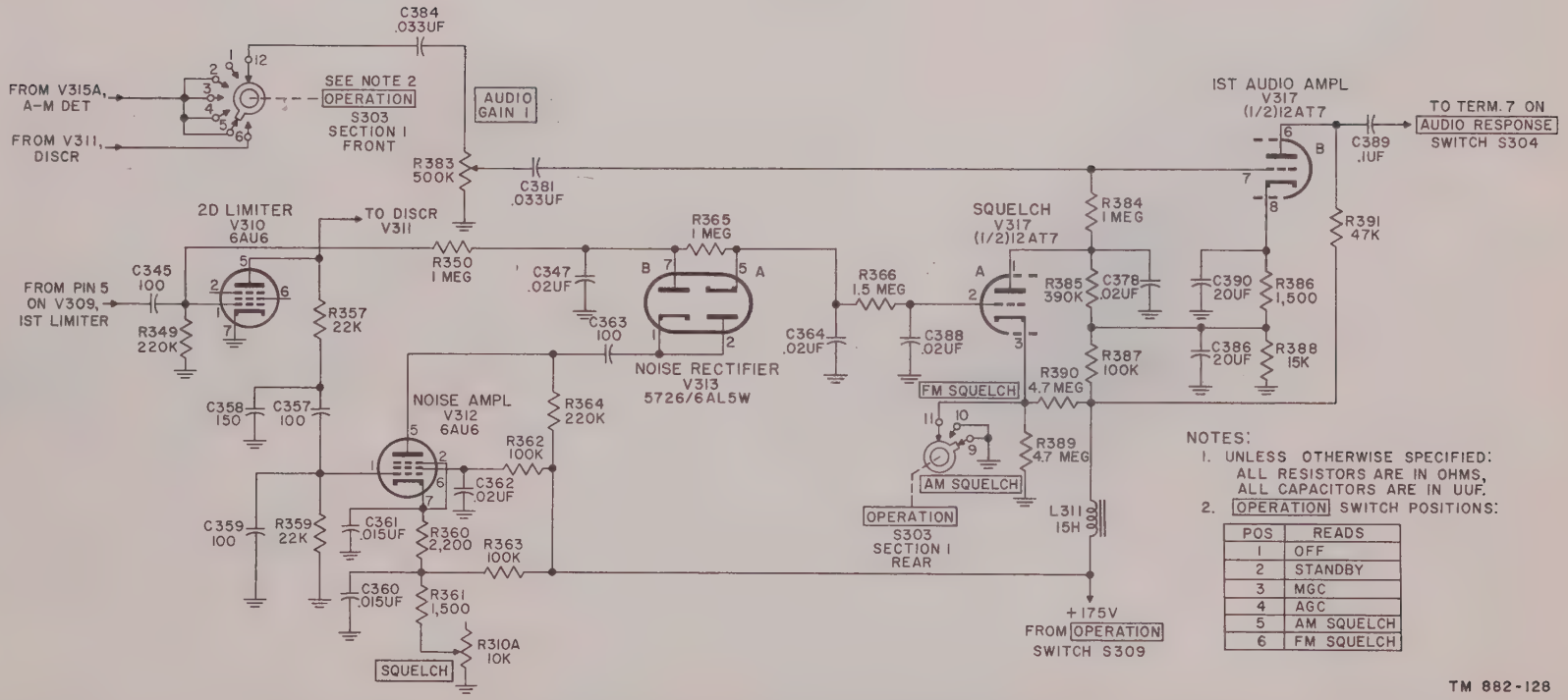


Figure 65. Squelch and first audio amplifier circuits.

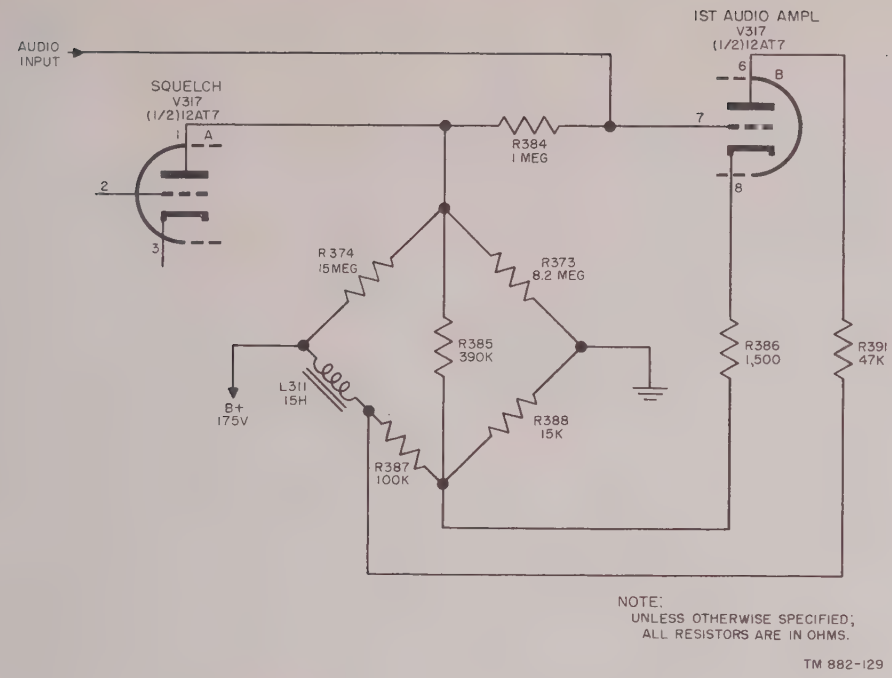


Figure 66. Bias arrangement of first audio amplifier.

and furnishes a negative voltage which is used to "squelch" the first audio amplifier, making it inoperative. The setting of the SQUELCH control R310A determines the r-f signal strength required to open the squelch. The SQUELCH control is set at the point where the noise at the speaker is just quieted or "squelched". A higher setting will block the receiver from reception of the weak signals.

c. Second Limiter Circuit (figs. 54 and 65). Normally in virtual saturation from noise excitation alone, the second limiter, V310, draws increasing grid current as the signal strength increases. Second limiter grid current is thus an indication of r-f signal strength and it is used in a control circuit to turn the receiver output circuits *on* only when a predetermined signal strength is reached. (For description of limiter stages, see paragraph 73.) When no r-f carrier signal is being received, all r-f noise from V310 is fed through decoupling resistor R357 and a frequency selective network (C357 and R359) to the grid of the noise amplifier, V312. The flow of grid current in V310 results in the grid end of R349 becoming negative with respect to ground. This negative voltage is applied through R350 to the noise rectifier, V313, and this negative voltage increases whenever the grid current through V310 increases due to the application of a signal through C345.

d. Noise Amplifier Circuit. The noise output from V310 is amplified by the noise amplifier V312 and coupled by means of C363 to the noise rectifier, V313. The SQUELCH threshold control, R310A, varies the cathode bias and thus the gain of the noise amplifier. R310A is part of a voltage divider network consisting of R363, R361, and R310A, with 175 volts B+ applied to the junction of R363 with the plate load and screen grid voltage-dropping resistors (R364 and R362). Cathode bias resistors are R360, R361, and R310A. C360, C361, and C362 are r-f bypass capacitors.

e. Noise Rectifier. The noise output from V310, after being amplified by V312 and fed to the noise rectifier, develops a d-c voltage across R365, negative at the anode (pin 7) and positive at the cathode (pin 5). C364, connected between pin 5 and ground, acquires a positive charge, which is transferred through R366 to C388. A negative voltage developed by second limiter grid current is applied across R350 and R365 and also appears across C364; this voltage is negative at pin 5 with respect to ground. The

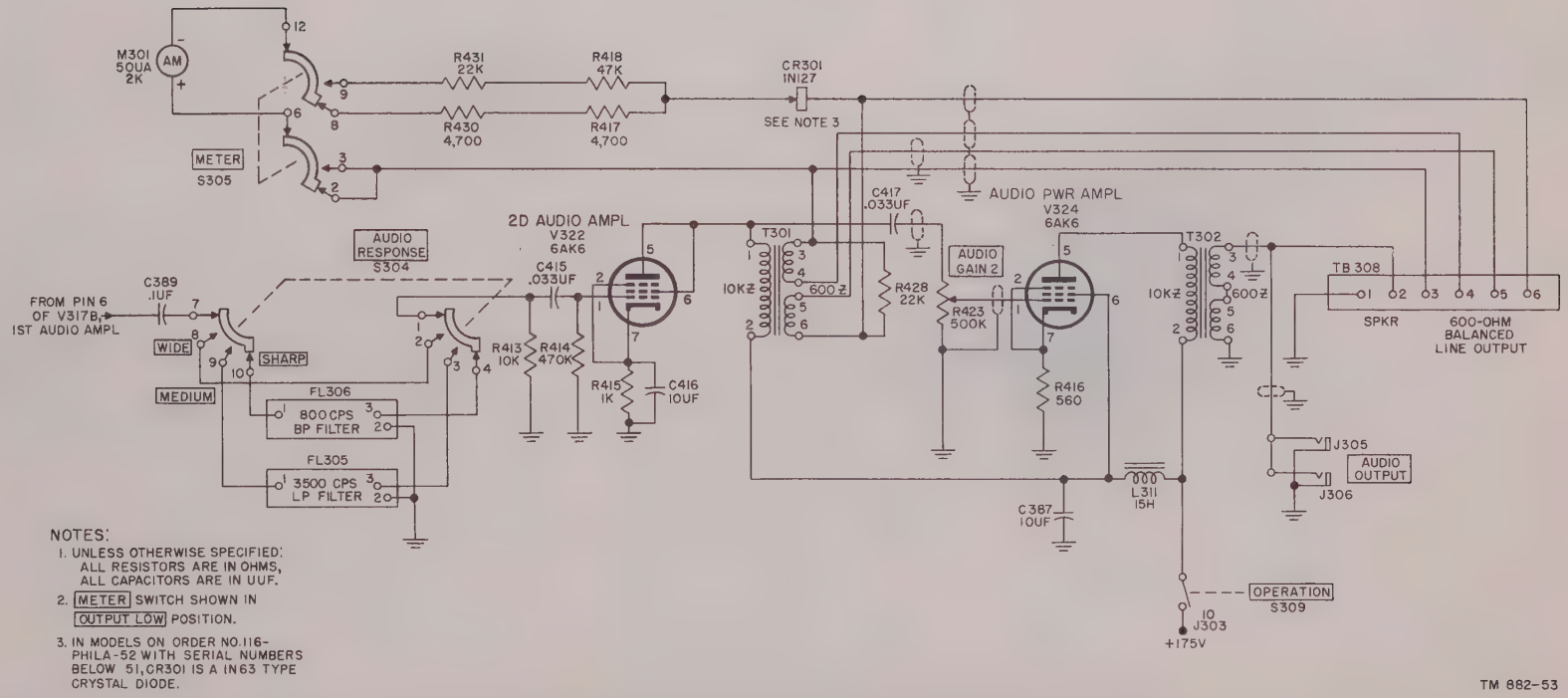


Figure 67. Second audio and power amplifiers.

algebraic sum of the positive noise voltage and the negative limiter voltage appears across C364 and forms a bias voltage for the d-c amplifier, V317A, at pin 2. Normal squelch-closed threshold voltage will be approximately 0 to +.5 volt. Since the grid bias voltage is zero or positive, the d-c amplifier conducts. When an r-f carrier signal is received, the second limiter draws increasing grid current. This makes the limiter grid voltage more negative, overcoming the positive noise voltage. As the sum voltage becomes negative, the d-c amplifier is cut off. Thus the d-c amplifier, V317A, is conducting when there is no r-f signal being received and nonconducting when a signal is received. A time delay is provided by R366 and C388 to smooth out rapid noise or voltage fluctuations. When V317A is conducting, the drop in plate voltage through R385 biases the audio amplifier, V317B, beyond cutoff and, with no amplification in this audio stage, the speaker is quiet. When V317A is non-conducting, the audio amplifier is biased to normal operation, and the signal is heard at the speaker.

f. First Audio Amplifier (figs. 65 and 66).

(1) The audio signal, whether from the a-m detector or from the discriminator, reaches the first audio amplifier, V317B, through the OPERATION switch, S303, section 1 front, the signal being coupled through C384, R383, and C381 to the grid of V317B (fig. 65). The AUDIO GAIN 1 control, R383, varies the signal amplitude applied to the grid, the a-c voltage being developed across the grid return resistor, R384. The audio tube, V317B, conducts only when the squelch tube, V317A, is not conducting; that is, when a sufficiently strong signal is being received. The audio tube does not conduct when the squelch tube is conducting; that is, when noise (or very weak signals) are being received. Thus, noise from inside the receiver is squelched by means of a control voltage from the squelch tube. This control voltage comes from the junction of R373 and R374 and is applied at the junction of R384 and R385 (fig. 66). When the squelch tube is conducting, the bias voltage developed across R385 prevents V317B from operating. When the squelch tube is not conducting, the bias voltage across R385 drops to a low value, which is due entirely to bleeder current and this reduced voltage across R385 which results from the bleeder current opposes the bias voltage developed across the cathode bias resistor, R386. The resulting bias voltage permits V317B to conduct.

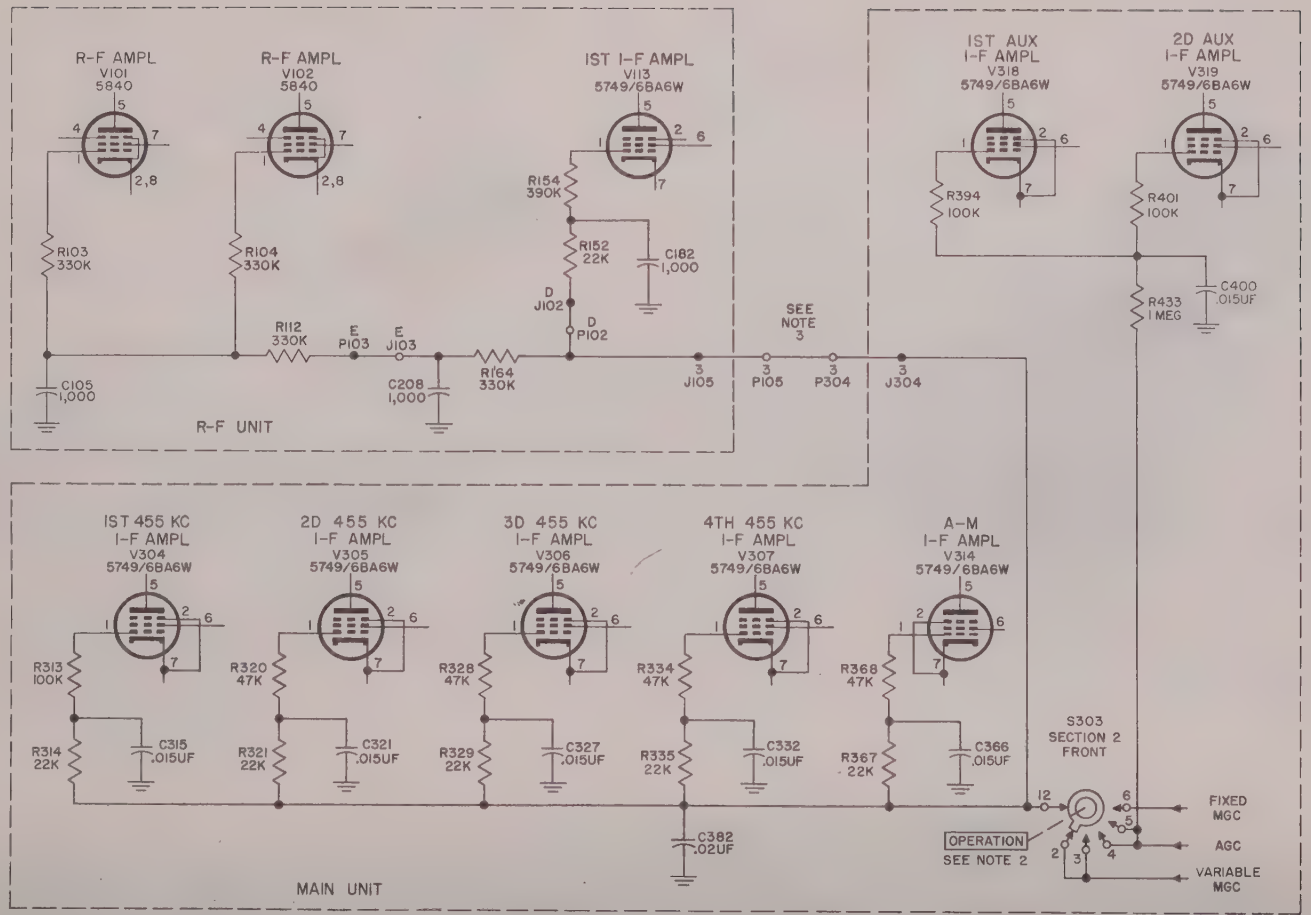
(2) Plate voltage is applied through the reactor, L311, and plate load resistor, R391, to V317B (fig. 66). The plate load resistor for V317A is R374. C390 is the cathode bypass capacitor for V317B (fig. 65). C386 and C378 are bypass capacitors. The output of V317B is coupled by C389 to the AUDIO RESPONSE switch, S304.

g. Application (fig. 65). When OPERATION switch S303 is in the STANDBY position, S309 is open and plate voltage is removed from the receiver (with the exception of the first hfo). In positions 2, 3, and 4, S309 is closed and the receiver is operating, but the squelch circuit is inoperative due to the high positive bias applied to the cathode of V317A through R390. In positions 5 or 6 on the OPERATION switch, the cathode is grounded to restore operation.

77. Second Audio and Power Amplifiers

(fig. 67)

a. The AUDIO RESPONSE switch, S304, which receives the signal from the first audio stage, is used to select the WIDE, MEDIUM, or SHARP filter through which the signal passes to the second audio amplifier circuit. R413 is the filter loading resistor and C415 couples the signal to the control grid of V322, the second audio amplifier. R414 is the grid return resistor, R415 is the cathode bias resistor, and C416 is the cathode bypass capacitor. B+ is applied to the plate and screen grid through T301, which is an impedance matching transformer, with the primary acting as the plate load impedance. The secondary provides a balanced 600-ohm output available at TB308. R428 is a load resistor across the secondary of T301 to keep the primary at a constant impedance.



NOTES:

1. UNLESS OTHERWISE SPECIFIED; ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. OPERATION SWITCH POSITIONS:

POS	READS
1	OFF
2	STANDBY
3	MGC
4	AGC
5	AM SQUELCH
6	FM SQUELCH

3. THE R-F UNIT AND MAIN UNIT ARE INTERCONNECTED BY CABLE ASSEMBLY W302.

TM 882-121

Figure 68. Mgc and agc distribution.

b. The output of the second audio amplifier is measured by the meter across the secondary of T301. CR301 rectifies the audio voltage. R417, R430, R418, and R431 are voltage dropping resistors to provide for measurement of a wide range of signal strengths. (See par. 82.)

c. The output of the second audio amplifier is coupled by C417 to the control grid of V324, the power amplifier. R423 (AUDIO GAIN 2) is the grid resistor and is used to control the audio output level to front panel jacks J305 and J306 and to terminals 1 and 2 of terminal board TB308. R416 is the cathode bias resistor. B+ from S309 is applied to the plate of V324 through T302. Screen grid voltage for V324 is applied through the audio filter choke, L311, and bypassed by C387. The secondary of T302 is a 600-ohm output connected to J305 and J306 for speaker use, and to TB308 for line or auxiliary use.

78. Mgc and Agc Control Circuits

(figs. 68 and 69)

a. General. Manual and automatic gain control voltage is applied to the r-f amplifier tubes, the first i-f amplifier, the four 455-kc i-f amplifiers, the a-m i-f amplifier, and the first and second auxiliary i-f amplifiers. The grid circuits of all these tubes receive a negative bias from either the mgc rectifier V303A, or the agc diode, V316. Both V303 and V316 are twin diodes, but only one diode section (A) of V303 is used as the mgc rectifier. The agc tube, V316, uses both diode sections as a voltage doubler.

b. Manual Gain Control. Manual gain control voltage is developed in the 2205-kc oscillator and capacity coupled through C308 to the cathode of the manual gain control rectifier, V303A. R306 is the cathode load resistor. The rectified voltage at the plate is filtered by the network composed of C310, R309, and C311. The rectified and filtered voltage, negative with respect to ground, is taken from R310B, the R.F. GAIN control, and sent to the OPERATION switch. This voltage is used for MGC operation. A fixed negative voltage from the other side of R310B is also sent to the OPERATION switch and is used for FM SQUELCH operation. The same front panel control is used to operate the R.F. GAIN (R310B) and the SQUELCH threshold, R310A, but whenever one of these circuits is operating, the other is disconnected by means of S303, section 2.

c. Automatic Gain Control.

(1) *Description of circuit.* Automatic gain control voltage from the agc circuit is also fed to the OPERATION switch. This voltage is used in the AGC and AM SQUELCH positions. Agc voltage is obtained from the output of the f-m i-f amplifier, V308, and coupled through R432 and C376 to the cathode of V316B and the plate of V316A. The tube rectifies this voltage (as in detector operation) and the d-c output is proportional to the average signal input. This output appears across R378, R429, and R377, being negative at pin 7 of V316B with respect to ground. The output is filtered by C377, R379, and C379 and this voltage is fed to the OPERATION switch, becoming part of the gain control circuit between terminal 12 of S303, (section 2), and ground. Since this is a negative voltage, it has the effect of increasing the negative bias applied to the tubes which are affected. Agc automatically controls the gain of these stages in inverse proportion to the signal strength, thus keeping the receiver output constant over a wide range of input signal levels.

(2) *Auxiliary voltage divider.* An auxiliary voltage divider network consisting of R433 and R434 is connected between section 2 of S303 and ground in order to provide about two-thirds of the agc voltage to the first and second auxiliary i-f amplifiers, independent of the OPERATION switch. C400 is an r-f bypass capacitor.

(3) *Agc regulation.* A positive voltage from the second auxiliary i-f amplifier, V319, is fed to the cathode, pin 5, of V316A, to render V316A inoperative at low signal levels. The positive voltage across R404 opposes the negative voltage across R378, R429, and R377, so that agc is not effective at low signal levels, the r-f voltage is insufficient to overcome the cathode bias of V316B. Under these conditions,

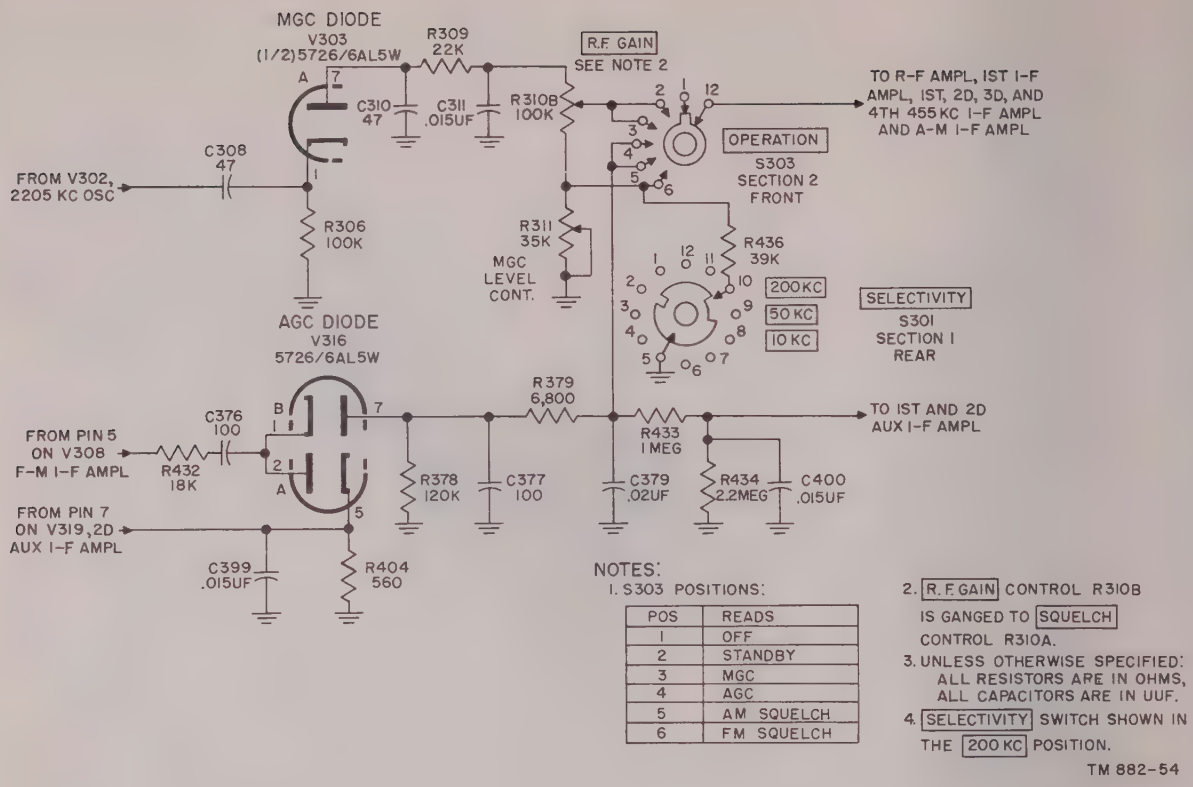


Figure 69. Gain control circuits.

V316B acts as a normal half-wave rectifier. As the signal is increased beyond the point where its peak positive value is more than the voltage on the cathode of V316A, however, V316A conducts, charging C376. This voltage adds to the peak value of the following (negative) half-cycle. The circuit now acts as a half-wave voltage doubler.

d. Metering Circuit. A metering circuit is placed in the plate circuit of V316B to measure the average strength of the carrier signal. The meter calibration is adjusted by the carrier meter center control, R429, at the rear of the receiver.

79. Power Supply and B+ Voltage Distribution

(figs. 125, 126, and 127)

a. Power Supply PP–660/URR is energized by 115-volt or 230-volt a-c through the connector J603, and turned on or off by S310, ganged to the OPERATION control. The 3-ampere fuse, F602, provides protection to the power supply from overload. Two bypass capacitors, C606 and C607, filter out any r-f voltage that may be present on the a-c line. Input power is applied to the two primary windings of the power transformer, T601. When the a-c line switch, S601, is set at the 115 position, the two primary windings are connected in parallel. Setting S601 at the 230 position connects the primaries in series. Each primary winding is rated at 115 volts, 48 to 62 cycles.

b. The three secondary windings of T601 provide all necessary operating voltages for the receiver. Secondary winding 10-11-12 provides 26 volts a-c between terminals 10 and 12 for the filaments of tubes located in the main unit of the receiver, and the same winding provides 6.3 volts a-c between terminals 11 and 12 for the filaments of tubes in the r-f unit. The full-wave rectifier, V601, obtains 5 volts a-c for its filament from terminals 8 and 9 connected to a separate secondary winding, and the high-volt-

age secondary winding, 5-6-7, provides 217 volts a-c each side of the center tap, terminal 6. The center tap is grounded and terminals 5 and 7 are connected to plates 6 and 4, respectively, of V601. Each half of the tube conducts during alternate half cycles. The rectified output is taken from pin 8 of V601 and filtered by C608, L602, and C609. The parallel resonant circuit consisting of L602 and C610 offers maximum impedance to the ripple frequency. Voltage regulation is improved by the bleeder resistor R601. All outputs of the power supply are connected to J604.

c. Power for the main and r-f units is available when cable connectors J604, J303, J304, and J105 are interconnected by the two power cables, and when J603 is connected to a suitable power source. B+ is turned on and off by S309, which is ganged to the OPERATION control. When the OPERATION control is in the OFF position, all power is removed from the receiver. In the STANDBY position, 105 volts d-c is applied to the plate and screen grid of the first hfo and to the discriminator meter center control. All other B+ circuits remain off. In all other switch positions, B+ is on.

d. The plate and screen grid voltages of all tubes on the main and r-f units except V110 are supplied through S309. B+ for the first hfo, V110, is regulated by V323, the voltage regulator tube. This tube has a variable internal resistance that is directly proportional to the current being drawn, thus keeping the supply voltage for V110 at a constant value. Since agc-mgc bias is used throughout the receiver, removal of plate and screen voltage will also remove all bias. In the STANDBY position, the grid bias circuits are completed through R310B and R311, but they remain inoperative until B+ is applied through S309.

80. Filament Circuits

(fig. 128)

a. Main Unit. Filament current for all tubes in the main unit enters through terminal 15 on J303. The 26-volts a-c available at terminal 15 is bypassed by C419 and divided into three circuits.

(1) The electron tube filaments in the main unit are wired in a series-parallel arrangement consisting of five series circuits and one series-parallel circuit, with six circuits connected in parallel. Where four tubes are connected in series, the 26 volts is evenly distributed across their filaments. One of these circuits contains a 12-volt tube, V317, but since its two 6-volt filaments are connected in parallel, the balance of the circuit is not disturbed. In this circuit, V322 and V324 are also parallel connected. Two of the series circuits contain only three tubes each. In these circuits the voltage drop is equalized by means of R421 and R422. Capacitor C427 bypasses the filaments of V301, V302, and V303. The filament of the beat frequency oscillator, V321, is isolated from the f-m i-f amplifier and limiter tubes, V308, V309, and V310, by the r-f choke L314 and the r-f bypass capacitor C420.

(2) A second connection is made to terminal 15 on J303 in order to drop the 26-volts a-c through voltage regulator RT301 to 6.3 volts a-c for the first hfo heater. This regulated voltage is available at terminal 7 of J304.

(3) Dial lamps I301 and I302 are connected in series with each other and with the DIAL LIGHT control, R392, which is ganged to S307 on the front panel. Rotation of R392 increases or decreases the voltage applied to the dial lamps, thereby controlling the extent of panel illumination.

b. R-f Unit. Terminal 14 of J303 is interconnected in the main unit with J304. Filament power for the r-f unit is thus available at terminal 14 on J105. With the exception of the first hfo, V110, all tube filaments on the r-f unit are supplied from terminal 14 on J105.

(1) The V110 filament receives its regulated voltage from terminal 7 on J105. This voltage is filtered by C219, L127, C217, and L104.

(2) Through terminal C on J102, 6.3-volts a-c is applied to V111, V112, and V113, connected in parallel, with C168 and C199 serving as r-f bypass capacitors for all three tubes. An L-C

(inductance-capacitance) filter is connected in series with each of these tubes.

(3) The remaining tubes on the r-f unit receive their filament voltage through terminal D on J103. The r-f bypass capacitor at this point is C267. The twelve tubes are arranged in six parallel groups, with an r-f choke and bypass capacitor for each group. Four of these tubes, V101, V102, V103, and V104, receive filament current from J103 through their respective filter chokes, L118 and L119. Additional filtering for the remaining eight tubes is provided by FL101, C212, and C189.

Section IV. CONTROL CIRCUITS

81. OPERATION Control

(fig. 70)

a. General. A rotary switch, S303, is ganged to two SPST (single-pole, single-throw) sensitive microswitches, S310 and S309, and is operated from the front panel by the OPERATION control. The microswitches are identical in construction, differing from each other only in function. The rotary switch consists of two sections. Section 1 is equipped with a set of contacts on the front and another set of contacts on the rear; section 2 has one set of contacts only, located on the front. Since each set of contacts consists of six terminal positions, the rotary switch is effectively a 3-pole, 6-position device.

b. Purpose. The first section, front, of S303 is used to transfer the audio signal from the a-m detector or f-m discriminator to the first audio amplifier. The rear contacts on this section are used to ground the cathode of V317A when either AM SQUELCH or FM SQUELCH is used. The second section of S303 controls the agc-mgc circuits. S310 is in series with the a-c line and serves as an on-off switch. S309 is the B+ switch. All plate, screen, and bias voltages, with the exception of B+ to the first hfo and meter M301, are removed from the receiver when S309 is open.

c. Application. In the first position of the OPERATION control, the a-c line is open and the receiver is inoperative, as shown. S601 on the power supply is set to either the 115 or the 230 position, according to the power source being used. Rotating the control to position 2 (STANDBY) applies filament voltage to all tubes, including the rectifier, and closes the circuit to the oscillator heater element. Plate and screen voltage is also applied to V110. B+ is applied to the remaining tubes in positions 3, 4, 5, and 6. Mgc is also available at position 3, and agc at position 4. The squelch circuit is in operation in positions 5 and 6, position 5 closing the circuit from the a-m detector and position 6 selecting the discriminator output. The R.F. GAIN–SQUELCH control operates the r-f gain only when the OPERATION control is in the MGC position. This control regulates the squelch threshold only when the OPERATION switch is in positions 5 or 6.

82. Meter Circuits

(figs. 71 and 72)

a. General (fig. 71). Meter M301 on the front panel is a microammeter with a resistance of approximately 2000 ohms and requiring 50 micromperes for full-scale deflection. It is accurate to within ±2 percent. The meter face is equipped with four scales: CARR. db, DBM HIGH, DBM LOW, and 0 to 50 microamperes. The top scale (CARR. db) is calibrated in db (decibels) and the two lower scales are calibrated in units of DBM, which is an audio power level referenced to one mw (milliwatt) of audio power developed across a 600-ohm load. The 25-microampere position on the lowest scale is plainly indicated for use with the discriminator meter center control.

b. Purpose and Use (fig. 72). The METER switch, S305, switches the meter to any one of five positions. These positions are CARRIER, OUTPUT LOW, OUTPUT HIGH, LIMITER, and DISC.

(1) *Position 1, CARRIER.* The d-c output from the agc diode V316 is applied to the grid bias circuit at the junction of R378 and R379, where it is negative with respect to ground. Since this voltage is proportional to the average signal input, the current through R429 will vary accordingly. A portion of

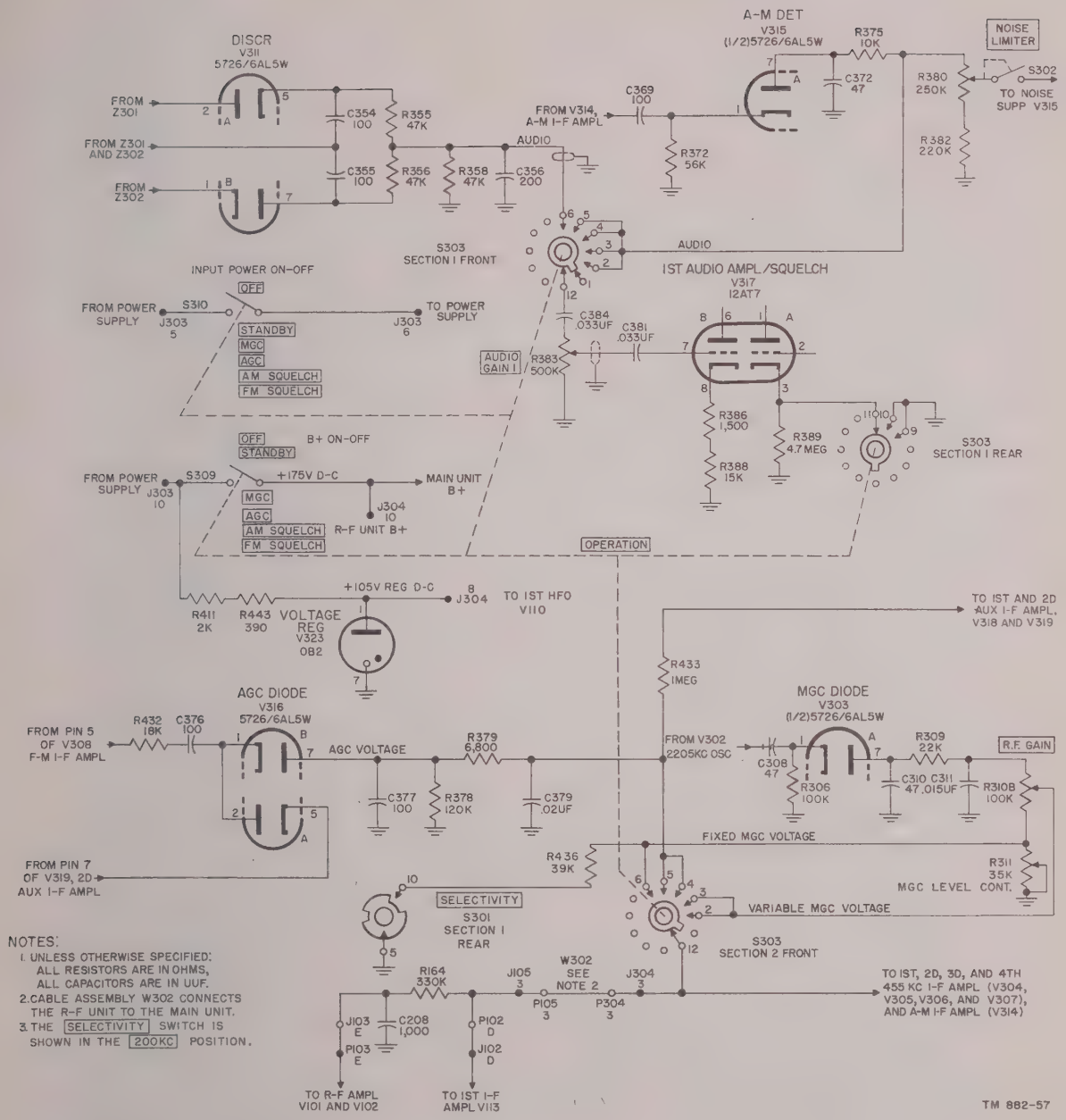


Figure 70. OPERATION control.

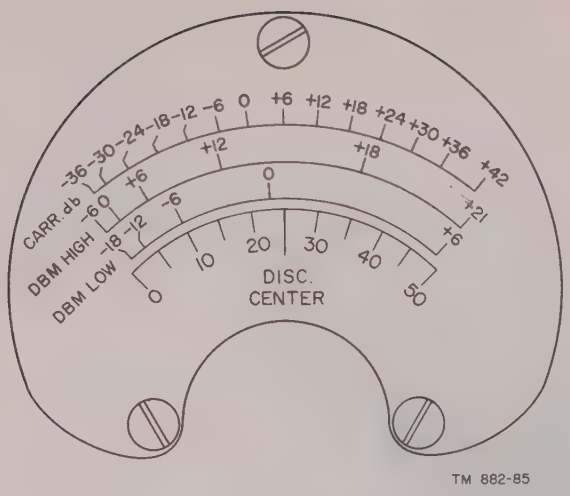


Figure 71. Meter scale.

this current is taken from R429 and fed through S305 to M301, returning through S305 to ground. Carrier level in decibels is read directly on the CARR. db scale of M301.

(2) *Position 2, OUTPUT LOW.* The 600-ohm balanced line output provided by T301 to terminals 3 and 6 of TB308 is shunted across the two secondaries of T301 by the constant impedance load resistor R428 and when S305 is set to position 2, M301 is shunted across R428. The a-c output is rectified by the germanium crystal unit CR301 and the rectified voltage is dropped through R417 and R430 to operate the meter. Thus audio power levels as low as —18 dbm may be read on the DBM LOW scale.

(3) *Position 3, OUTPUT HIGH.* The only difference in this circuit from position 2 is that the rectified current is fed to S305 through R418 and R431 instead of R417 and R430. This position effectively extends the meter scale to +21 dbm. OUTPUT HIGH is read on the DBM HIGH scale.

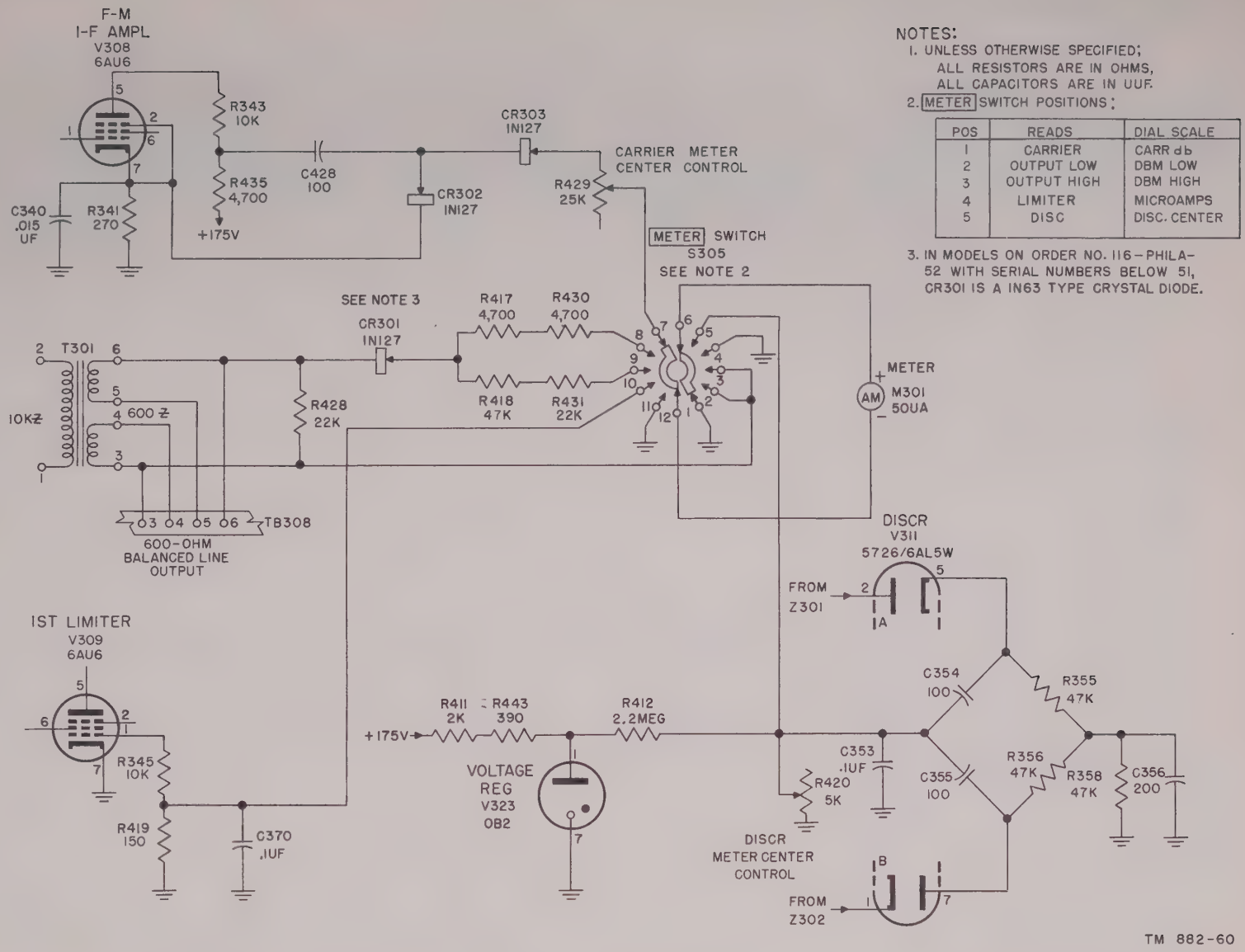
(4) *Position 4, LIMITER.* Limiter current is taken from the grid circuit of first limiter V309 at the junction of R419 and R345, which is negative with respect to ground. It is then fed through S305 to M301 and returns through ground to V309. Limiter current, in microamperes, is read directly on the lowest scale of M301.

(5) *Position 5, DISC.* A regulated 105 volts d-c from V323 is dropped by R412 to effect a half-scale deflection of M301. The needle is centered on the DISC. CENTER scale by means of the discriminator meter center control, R420. This is a screw driver adjustment, performed with no signal applied. When the discriminator, V311, is in operation, both sections of the tube conduct at the center frequency, 455 kc, but in opposite directions, so that no voltage appears at the condition of proper balance and M301 continues to be deflected at 25 microamperes due to the regulated voltage from V323. When the discriminator is unbalanced, however, only one section of the tube conducts. This results in a voltage output at the junction of C354 and C355. The output from this point is fed to M301 at the junction of R412 and R420 and this output acts to either increase or decrease the current to M301, causing a deflection either to the right or left.

83. BAND SELECTOR and TUNING Controls

(fig. 129)

a. General. All band switching and band tuning devices are located in the r-f unit. Band switching is accomplished by means of seven turret assemblies, a two-position rotary switch, and a six-section, seven-position rotary switch, all turrets and switches being ganged by mechanical gearing to the BAND SELECTOR control on the front panel. Each turret assembly consists of seven tuned circuits, one for each band within the range of the receiver. The six-section rotary switch, S101, also has seven positions, one for each band. The two-position rotary switch S102 alternates between the odd numbered bands, 1, 3, 5, and 7, and the even bands, 2, 4, and 6. All tuning capacitors in the r-f unit are ganged to another gear train and operated from the front panel by means of the TUNING control.



NOTES:

1. UNLESS OTHERWISE SPECIFIED; ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. METER SWITCH POSITIONS;

POS	READS	DIAL SCALE
1	CARRIER	CARR db
2	OUTPUT LOW	DBM LOW
3	OUTPUT HIGH	DBM HIGH
4	LIMITER	MICROAMPS
5	DISC	DISC. CENTER

3. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS BELOW 51, CR301 IS A IN63 TYPE CRYSTAL DIODE.

Figure 72. Meter circuits.

b. Purpose and Use. Band switching is used in the r-f amplifier, first mixer, third multiplier buffer, first, second and third multipliers, first high frequency oscillator, first i-f amplifier, second high frequency oscillator, and second mixer circuits. Band tuning is used in the r-f amplifier, first mixer, first, second and third multipliers and first high frequency oscillator circuits. The purpose of the band switching arrangement is to provide a convenient means whereby the proper tuned circuits consisting of grid and plate tanks, i-f transformers, and second hfo crystals may be quickly selected from the front panel by means of a single switch. The band tuning arrangement permits tuning any band within the range of the receiver from the front panel with a single control.

c. Frequency Chart. The following chart shows the various frequencies throughout the r-f unit signal path, in tabular form. The frequencies indicated refer to the minimum and maximum frequency response of each unit. Where only one frequency is indicated, the response range is ±200 kc. The bands overlap, to provide continuous coverage, and there is a margin of at least 200-kc frequency deviation at the beginning and end of each band to allow for transmitter modulation. In addition to meeting specifications (par. 4) as high as 230.200 mc, band 7 has an extended range up to 237.976 mc. The columns contain the frequency of any band through all sections of the r-f unit. The rows indicate the frequency in any tuning unit for all bands.

Tuning unit	Frequency (mc)						
	Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7
Turret Z150	19.746 to 29.747	27.985 to 42.158	39.492 to 59.494	55.970 to 84.316	78.984 to 118.988	111.940 to 168.632	157.968 to 237.976
Turret Z151	19.746 to 29.747	27.985 to 42.158	39.492 to 59.494	55.970 to 84.316	78.984 to 118.988	111.940 to 168.632	157.968 to 237.976
Turret Z152	19.746 to 29.747	27.985 to 42.158	39.492 to 59.494	55.970 to 84.316	78.984 to 118.988	111.940 to 168.632	157.968 to 237.976
1st hfo output	13.6523 to 23.6523	9.674 to 16.761	13.6523 to 23.6523	9.674 to 16.761	13.6523 to 23.6523	9.674 to 16.761	13.6523 to 23.6523
Turret Z156	13.6523 to 23.6523	19.348 to 33.522	27.3046 to 47.3046	19.348 to 33.522	27.3046 to 47.3046	19.348 to 33.522	27.3046 to 47.3046
Turret Z155	13.6523 to 23.6523	19.348 to 33.522	27.3046 to 47.3046	38.696 to 67.044	54.6092 to 94.6092	38.696 to 67.044	54.6092 to 94.6092
Turret Z154	13.6523 to 23.6523	19.348 to 33.522	27.3046 to 47.3046	38.696 to 67.044	54.6092 to 94.6092	77.392 to 134.088	109.2184 to 189.2184
Turret Z153	13.6523 to 23.6523	19.348 to 33.522	27.3046 to 47.3046	38.696 to 67.044	54.6092 to 94.6092	77.392 to 134.088	109.2184 to 189.2184
T101	6.0942	8.6369	12.1884	17.2738	24.3767	34.5476	48.7535
T102	6.0942	8.6369	12.1884	17.2738	24.3767	34.5476	48.7535
2d hfo output	7.8442	6.8869	10.4384	15.5238	22.6267	32.7976	47.0035

CHAPTER 6

FIELD MAINTENANCE INSTRUCTIONS

Section I. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available, and by the skill of the repairman.

84. Trouble-shooting Procedures

The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the *major component or circuit* responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective *part* responsible for the abnormal condition. Some faults such as burned-out resistors, arcing, and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be localized by *checking voltage and resistance.*

a. System Sectionalization. System sectionalization is discussed in paragraph 45.

b. Component Sectionalization and Localization. The tests listed below aid in isolating the source of trouble. To be effective the procedure should be followed in the order given. Remember that servicing procedure should cause no further damage to the receiver. First, trouble should be localized to a single stage or circuit. Then the trouble may be isolated within that stage or circuit by appropriate voltage, resistance, and continuity measurements. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection is to locate any visible trouble. Through this inspection alone, the repairman may frequently discover the trouble or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the receiver which might occur through improper servicing methods and in forestalling future failures.

(2) *Input resistance measurement.* These measurements (par. 45) prevent further damage to the power supply from possible short circuits. Since this test gives an indication of the condition of the filter circuits, its function is more than preventive.

(3) *Operational test.* The operational test (par. 93) is important because it frequently indicates the general location of trouble. In many instances the information gained will determine the exact nature of the fault. In order to utilize this information fully, all symptoms must be interpreted in relation to one another.

(4) *Trouble-shooting chart.* The trouble symptoms listed in this chart (par. 94) will aid greatly in localizing trouble.

(5) *Signal substitution.* The principal advantage of the signal substitution method (par. 95) is that it usually enables the repairman to localize a trouble accurately and quickly to a given stage when the general location of the trouble is not immediately evident from the above tests.

(6) *Stage gain charts.* These charts (par. 97) can be used to localize obscure, hard-to-find troubles.

(7) *Intermittents.* In all these tests the possibility of intermittents should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the set. It is possible that the trouble is not in the receiver itself but in the installation (mounting, interphone system, or vehicle), or the trouble may be due to external conditions. In this event, test the installation, if possible.

85. Trouble-shooting Data

Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Consult the following trouble-shooting data:

a. Radio Receiver R–220/URR.

Par. No.	Fig. No.	Description
	22	Tube location, main unit.
	23	Tube location, right side of r-f unit.
	24	Tube location, left side of r-f unit.
	30	Radio Receiver R-220/URR, main unit, location of tubes.
	75	Radio Receiver R-220/URR, under chassis view.
	76	Radio Receiver R-220/URR, main unit, location of sections E through K.
	77	Parts location, main unit, section E.
	78	Parts location, main unit, section F.
	79	Parts location, main unit, section G, showing capacitors.
	80	Parts location, main unit, section G, showing resistors.
	81	Parts location, main unit, section H.
	82	Parts location, main unit, section J, showing resistors.
	83	Parts location, main unit, section J, showing capacitors.
	84	Parts location, main unit, section K, showing resistors.
	85	Parts location, main unit, section K, showing capacitors.
	86	Sections E, F, and H, voltage and resistance measurements.
	87	Section G, voltage and resistance measurements.
	88	Section J, voltage and resistance measurements.
	89	Section K, voltage and resistance measurements.
	90	R-f unit, oscillator side.
	92	R-f unit, location of sections A through D.
	93	R-f unit, section A.
	94	R-f unit, sections B and D.
	95	R-f unit, section C, top view.
	98	Second hfo, part location.
	99	First mixer section, voltage and resistance measurements.
	100	Second mixer and first hfo sections, voltage and resistance measurements.
	101	R-f unit, bottom view.
	102	R-f unit, rear view.
	103	Control head over-all view.
	132	Radio Receiver R-220/URR, schematic diagram.
45		Sectionalization of trouble to a unit.
47		Equipment performance checklist.
48		Trouble-shooting chart for Radio Receiving Set AN/URR-29.
86		Test equipment required for trouble shooting.
92		Checking key circuits for shorts.
94		Trouble-shooting charts.
95		Signal substitution.
97		Stage gain charts.

b. Power Supply PP–660/URR.

Par. No.	Fig. No.	Description
	73	Power Supply PP-660/URR, bottom view.
	74	Power Supply PP-660/URR, voltage and resistance measurements.
	125	Power Supply PP-660/URR, schematic diagram.
47		Equipment performance checklist.
48		Trouble-shooting chart for Radio Receiving Set AN/URR-29.
86		Test equipment required for trouble shooting.
92		Checking key circuits for shorts.
94		Trouble-shooting charts.

86. Test Equipment Required for Trouble Shooting

The test equipment required for trouble shooting Radio Receiving Set AN/URR–29 is listed below along with the publication for each item. In addition to this equipment, Tool Equipment TE–113 and Tool Equipment TE–114 are available to third, fourth, and fifth echelon maintenance. Tool Equipments TE–33 and –41, and Moisture–Fungus Proofing Equipment MK–2/GSM are available for second echelon maintenance. A slotted alinement tool, an offset end wrench, and a spanner wrench are attached to the receiver chassis.

Test equipment	Publication
Multimeter TS-297/U	TM 11-5500
Multimeter TS-352/U	TM 11-5527
Electronic Multimeter TS-505/U	TM 11-5511
Electronic Multimeter ME-6A/U	TM 11-5549
Electron Tube Test Set TV-2/U	TM 11-2661 (when published)
Electron Tube Test Set TV-7/U	TM 11-5083
Frequency Meter FR-4	
Signal Generator TS-497/URR	TM 11-5030
Signal Generator SG-3/U	TM 11-1258
Signal Generator AN/URM-25	TM 11-5551
Panoramic Indicator IP-173/U	TM 11-5017
Analyzer, Spectrum TS-723/U	
Audio Oscillator TS-382A/U	TM 11-2684A
Frequency Meter Set SCR-211	TM 11-300
Frequency Meter FR-67/U	TM 11-2698
Output Meter TS-585/U	TM 11-5017

87. General Precautions

Whenever the equipment is serviced, observe the following precautions very carefully:

a. Be careful when working on the inside of the receiver with the power on; dangerous voltages are present.

b. Careless replacement of parts often makes new faults inevitable. Note the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each of the leads to it.

(2) Be careful not to damage other leads by pulling or pushing them out of the way.

(3) Do not allow drops of solder to fall into the set, since they may cause short circuits.

(4) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to find.

(5) When a part is replaced in r-f or i-f circuits, it must be placed exactly as the original. A part which has the same electrical value, but different physical size may cause trouble in high frequency circuits. Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring. Failure to observe these precautions may result in decreased gain or possibly in oscillation of the circuit.

88. Voltage Measurement

a. Precaution Against High Voltage. High voltages are dangerous and can be fatal. Certain precautions must be followed when measuring voltages above a hundred volts. When it is necessary to measure high voltages, observe the following rules:

(1) Connect the ground lead to the voltmeter.

(2) Ground the case or panel of metal test instruments.

(3) Place one hand in your pocket.

(4) If the voltage is less than 300 volts, checks may be made with power on by touching the probe of the test lead to the hot terminal.

b. Voltmeter Loading. It is essential that the voltmeter resistance be at least 10 times as large as the resistance of the circuit across which the voltage is measured. If the voltmeter resistance is comparable to the circuit resistance, the voltmeter will indicate a lower voltage than the actual voltage present.

(1) The resistance of the voltmeter can always be calculated by the following simple rule: The resistance of the voltmeter equals the ohms per volt multiplied by the full-scale range in volts.

(2) To minimize voltmeter loading in high-resistance circuits, use the highest voltmeter range. The decreased loading of the voltmeter more than compensates for the inaccuracy which results from reading only a small deflection on the scale of the voltmeter.

89. Resistance Measurements

a. General. When a fault develops in a circuit, its effect very often shows up as a change in the values of resistance readings. To assist

in the localization of faults, trouble-shooting data includes the normal resistance values as measured at the tube sockets and at test jacks or terminal boards. These values are measured between the indicated points and ground, unless otherwise stated.

(1) *Precautions.* Before making any resistance measurements, disconnect the power source. An ohmmeter is essentially a low-range voltmeter and battery. If the ohmmeter is connected in a circuit which already has voltages in it, the needle will be knocked off-scale and the voltmeter may be burned out. Electrolytic capacitors must always be discharged before resistance measurements are made.

(2) *Correct use of high and low ranges.* It is important to know when to use the low-resistance and high-resistance ranges of an ohmmeter when checking any circuit. When checking circuit continuity, the ohmmeter should be set on its lowest range. If a medium or high range is used, the pointer may indicate zero ohms, even if the resistance is as high as 500 ohms. When checking high resistances or measuring the leakage resistance of capacitors or cables, the highest range should be used. If a low range is used, the pointer will indicate infinity even though the actual resistance is less than a megohm.

(3) *Parallel resistance connections.* In a parallel circuit, the total resistance is less than the smallest resistance in the circuit. This is important to remember when trouble shooting with the aid of a schematic diagram. When the value of a measured resistance is found to be lower than expected, make a careful study of the schematic to be certain that there are no resistances in parallel with the one that has been measured. Before replacing a resistor, disconnect one terminal from the circuit and check the resistance again to make sure that the low reading was not due to another parallel connection such as a coil or transformer winding.

(4) *Tolerance values of resistance measurements.* The tolerance of a resistor refers to the difference between the rated value and the actual value of the resistor. Most resistors used in radio circuits have a tolerance of 10 percent. Let us assume the rated value of a grid resistor is said to be 1 megohm. If the actual measurement varies between .9 and 1.1 megohms, it will be considered normal. In the case of precision resistors and potentiometers, the tolerance allowed will be indicated on the part. The tolerance value for transformer windings is usually between 1 and 5 percent. Any transformer winding showing more than that allowable deviation in resistance should be checked very closely.

b. High-resistance Measurements. Many leakages will not show up when measured at low voltages. It may be necessary to check the resistance of components to a common ground (transformer windings shorted to transformer case or core; conductors within a coaxial cable shorted to outer shield). To do this, connect a voltage supply of approximately 300 volts in series with the 300-volt range of a voltmeter and the suspected components. A leakage will be indicated by a voltage reading.

90. Capacitor Tests

Capacitors which are leaky or shorted can be found by resistance measurements. A capacitor suspected of being open can be checked by shunting a good capacitor of approximately the same value across it. It should be remembered that a leakage value of 50 to 100 microamperes per uf (microfarad) is normal for electrolytic capacitors. When using an ohmmeter to check electrolytics, the polarity of the capacitor must be observed.

91. Tube Checking

a. Failures. Tube failures are responsible for a large percentage of the faults which occur in radio sets. Do not attempt to find the source of trouble in these sets by indiscriminately changing tubes. Do not resort to tube changing until the trouble has been traced to a particular unit.

b. Checking. Tube checkers are used to check either the emission or the mutual conductance

of the tubes and to test for shorted elements. While they may not be used to test the performance of rectifiers, they are useful for checking receiving-type tubes. Remember that the results obtained with the tube checker are not the same as when the tube is operating in the set. For this reason, the final test of a tube is its replacement by a tube that is known to be good.

92. Checking Key Circuits for Shorts

a. When beginning the trouble-shooting procedure, always check the resistance of key circuits (B+ and filaments). Doing so may prevent damage to the power supply, or further damage to the receiver in the event a short or near short is present in the circuit.

b. Compare the resistance readings shown in paragraph 45 with those measured at J604, J303, J304, J105, P103, and J102. When the difference in readings is greater than 30 percent, consider the circuit defective. Continue resistance measurement of component parts within the circuit until the shorted or otherwise defective item is found. Replace the faulty component part before continuing with any further maintenance.

93. Operational Test

Operate the radio set as described in the equipment performance checklist in paragraph 47. This checklist is important because it frequently indicates the general location of trouble. Also listen for crackling or buzzing noises which indicate high-voltage arcing. Check the receiver for smoke and the odor of burned or overheated parts.

94. Trouble-shooting Charts

a. General. The charts in this paragraph will aid in rapidly localizing defects to any of the component parts of Radio Receiving Set AN/URR–29. A separate chart is listed for each of the three major units, (main unit, r-f unit, and power supply). The items shown in the *symptom* column are operating indications of a complete Radio Receiving Set AN/URR–29. The items listed in the *probable trouble* column are those component parts or stages thought to be defective. The items listed in the *correction* column are the necessary follow-up procedures required to correct the probable troubles. Voltage and resistance charts, referred to in figures 74, 86, 87, 88, 89, 99, and 100, aid in locating the defective component part after isolating the defective stage. Refer to the data given in paragraph 85.

Caution: Some of the corrective measures listed in the trouble-shooting charts refer to making voltage, resistance, and continuity checks. Make certain the power is on for voltage measurements and off for resistance or continuity checks.

b. Power Supply PP–660/URR.

Symptom	Probable trouble	Correction
1. Receiver inoperative; dial lamps and tube filaments on; no B+ output from power supply.	1. Shorted C608, C609, and/or R601; open L602.	1. Make voltage and resistance measurements (fig. 74); replace as necessary.
2. Receiver inoperative; dial lamps and tube filaments do not light.	2. Shorted C606 and C607; defective T601 or S601. Open fuse F602 or open wiring on J603.	2. Make voltage and resistance measurements (fig. 74); replace as necessary.
3. Excessive hum in audio output.	3. Leaky C608 and/or C609; shorted or open C610.	3. Check by substitution; replace if necessary.
4. Tube filaments in main unit do not light; all other filaments normal.	4. T601 secondary open.	4. Replace transformer.
5. Tube filament in power supply rectifier does not light; all other filaments normal.	5. T601 secondary open. Open filament in V601.	5. Replace transformer. Replace tube.

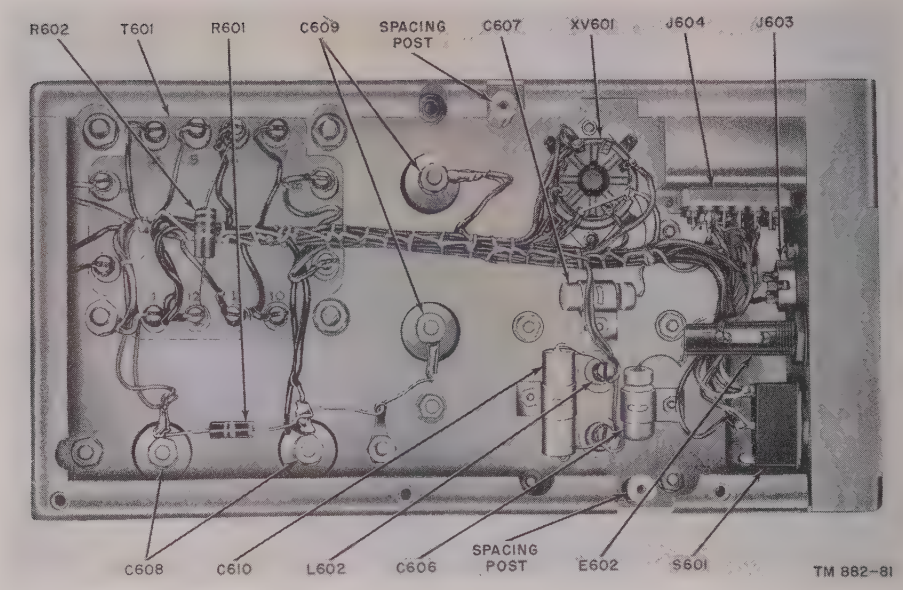
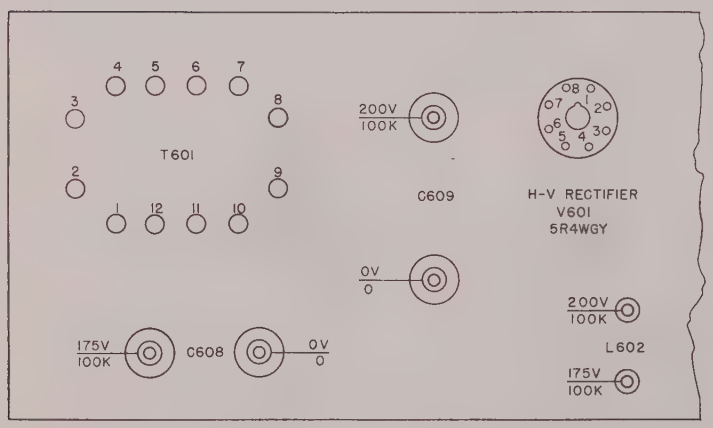


Figure 73. Power Supply PP-660/URR, bottom view.



T601

TERMINAL	VOLTAGE(A-C)	RESISTANCE
1 TO 2	115	40
3 TO 4	115	40
5 TO 6	228	20
6 TO 7	228	20
8 TO 9	5	LESS THAN 1
10 TO 11	20	LESS THAN 1
11 TO 12	6.3	LESS THAN 1

V601

PIN	VOLTAGE(A-C)	RESISTANCE
2 TO 8	5	LESS THAN 1
4 TO 6	456	40

J604

TERMINAL	VOLTAGE	RESISTANCE
3 TO 5	115V A-C	∞
5 TO 6	115V A-C	∞
10 TO 1	175V A-C	100K
14 TO 1	6.3V A-C	LESS THAN 1
15 TO 1	26V A-C	LESS THAN 1

J603

TERMINAL	VOLTAGE(A-C)	RESISTANCE
A TO D	115	∞

NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, UNLESS OTHERWISE SPECIFIED, MADE WITH A 20,000 OHMS PER VOLT METER.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND MAIN UNIT DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE OPERATION SWITCH IN THE MGC POSITION AND THE POWER SUPPLY CONNECTED TO A 115V A-C SOURCE.
3. NC INDICATES NO CONNECTION.

TM 882-138

Figure 74. Power Supply PP-660/URR, voltage and resistance measurements.

c. Main Unit.

Symptom	Probable trouble	Correction
1. No audio output; meter indication normal in OUTPUT LOW and OUTPUT HIGH positions.	1*a*. Defective headset. *b*. Defective audio power amplifier stage. *c*. Open AUDIO GAIN 2 potentiometer control (R423).	1*a*. Repair or replace. *b*. Check voltage and resistance measurements at V324 socket. *c*. Check resistance; replace if necessary.
2. No audio output. No meter indication in OUTPUT LOW and OUTPUT HIGH positions; all other readings normal.	2. Defective first audio amplifier V317 and/or second audio amplifier V322.	2. Check voltage and resistance measurements at V317 and/or V322 sockets.
3. No audio output during f-m operation; meter readings normal in CARRIER and LIMITER positions.	3. Defective first limiter V309, second limiter V310, and/or discriminator V311 stages.	3. Check voltage and resistance measurements at V309, V310, and/or V311 sockets.
4. No audio output during f-m operation; no meter reading in LIMITER position; meter reading normal in CARRIER position.	4. Defective first limiter stage V309.	4. Check voltage and resistance measurements at V309 socket.
5. No audio output during a-m operation; meter readings normal in CARRIER and LIMITER positions.	5. Defective a-m i-f amplifier V314 and/or a-m detector V315 stages.	5. Check voltage and resistance measurements at V314 and/or V315 sockets.
6. No audio output during a-m or f-m operation; no meter reading in CARRIER position.	6*a*. Defective i-f amplifiers V304, V305, V306, V307, third mixer V301, and/or 2205-kc osc V302. *b*. Defective 1.75-mc filter FL301.	6*a*. Check voltage and resistance at V304 through V307, V301 and/or V302. If defective component is not found, use signal substitution method (par. 95). *b*. Measure input resistance of filter; should read 3 ohms.
7. No reception of c-w signals.	7. Defective bfo V321.	7. Isolate the defective part using voltage and resistance measurements.
8. Reception normal; no meter reading in CARRIER position.	8. Defective f-m i-f amplifier V308 or agc diode V316.	8. Check voltage and resistance measurements at V308 or V316 sockets.
9. Receiver operation normal; no auxiliary diode output.	9. Defective first aux i-f amplifier V318, second aux i-f amplifier V319 or aux diode V320.	9. Check voltage and resistance measurements at V318, V319, and/or V320 sockets.
10. No noise limiter action.	10*a*. Defective noise suppressor V315. *b*. Defective NOISE LIMITER control.	10*a*. Check voltage and resistance measurements at V315 socket. *b*. Check resistance; replace if necessary.
11. Receiver will not squelch.	11*a*. Defective noise amplifier V312, noise rectifier V313, and/or squelch V317. *b*. Defective SQUELCH control R310A.	11*a*. Check voltage and resistance measurements at V312, V313, and/or V317 sockets. *b*. Check resistance, replace if necessary.

c. Main Unit (contd).

Symptom	Probable trouble	Correction
12. R.F. GAIN-SQUELCH inoperative when OPERATION switch is in the MGC position.	12*a*. Defective mgc diode V303.	12*a*. Check voltage and resistance measurements at V303 socket.
	b. Defective R.F. GAIN control R310B.	*b*. Check resistance; replace if necessary.
13. No audio output when AUDIO RESPONSE switch is set to the SHARP position.	13. Defective band-pass filter FL306.	13. Measure input and output resistance of filter; should read infinity and 94 ohms.
14. No audio output when AUDIO RESPONSE switch is set to the MEDIUM position.	14. Defective low-pass filter FL305.	14. Measure input and output resistance of filter; both readings should be infinity.
15. No audio output when AUDIO RESPONSE switch is set to the WIDE position.	15. Defective AUDIO RESPONSE switch S304.	15. Check continuity of switch; replace if necessary.
16. No audio output when SELECTIVITY switch is set to the 10 K.C. position.	16*a*. Defective 455-kc filter FL302.	16*a*. Measure input and output resistance of filter; should read 7 ohms each.
	b. Defective switch S301.	*b*. Check continuity through contacts; replace if necessary.
17. No audio output when SELECTIVITY switch is set to the 50 K.C. position.	17*a*. Defective 455-kc filter FL303.	17*a*. Measure input and output resistance of filter; should read 4 ohms each.
	b. Defective switch S301.	*b*. Check continuity through contacts; replace if necessary.
18. No audio output when SELECTIVITY switch is set to the 200 K.C. position.	18*a*. Defective 455-kc filter FL304.	18*a*. Measure input and output resistance of filter; should read 2,200 ohms and 10 ohms.
	b. Defective switch S301.	*b*. Check continuity through contacts; replace if necessary.
19. Receiver operates normally; no meter indications.	19*a*. Defective meter M301.	19*a*. Repair or replace.
	b. Defective METER switch S305.	*b*. Check and replace if necessary.
20. Receiver output lower than normal.	20. R-f section misalined. Leaky coupling capacitors C381, C384, C389, C415, and/or C417. Low B+ or line voltage.	20. Check leakage resistance (par. 90).
21. Receiver audio output distorted only during f-m operation.	21. Discriminator misalined.	21. Refer to to paragraph 112 for alinement.

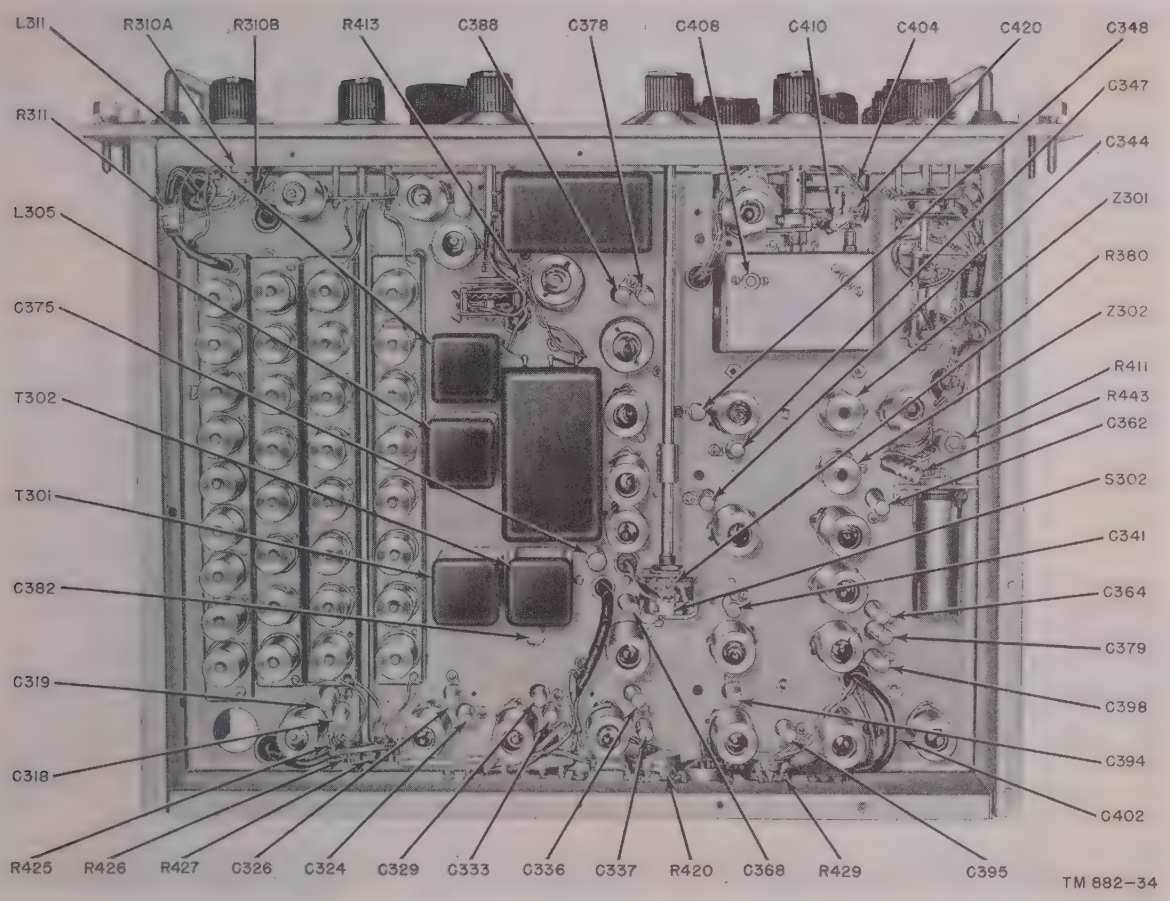


Figure 75. Radio Receiver R-220/URR, under chassis view.

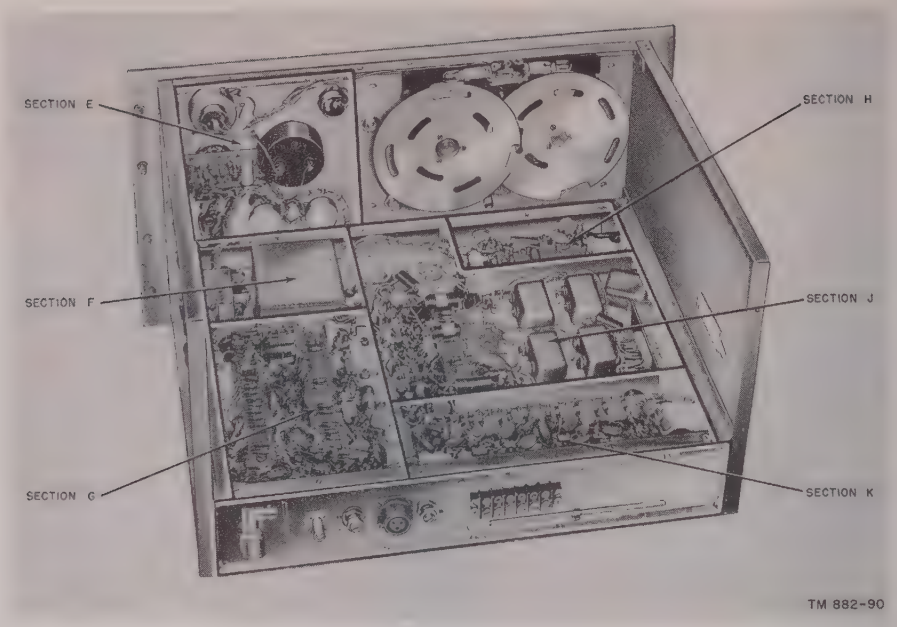


Figure 76. Radio Receiver R–220/URR, main unit, showing location of sections E through K.

d. R-f Unit.

Symptom	Probable trouble	Correction
1. Calibrator oscillator note heard in output, otherwise receiver inoperative.	1*a*. Defective antenna.	1*a*. Check antenna system.
	b. Defective r-f amplifiers V101 and/ or V102.	*b*. Check voltage and resistance measurements at V101 and/or V102 sockets.
	c. Defective Z150 and/or Z151.	*c*. Repair or replace.
2. Calibrator oscillator note not heard in output; receiver operates normally.	2*a*. Defective calibrator oscillator V115 and/or calibrator buffer V114.	2*a*. Check voltage and resistance measurements at V114 and/or V115 sockets.
	b. Calibrator oscillator misalined.	*b*. Refer to paragraph 115 for alinement procedure.
	c. Defective crystal Y101.	*c*. Replace.
3. Receiver inoperative on bands 6 and 7.	3. Defective third multiplier V105.	3. Check voltage and resistance measurements at V105 socket.
4. Receiver inoperative on bands 4, 5, 6, and 7.	4. Defective second multiplier V107.	4. Check voltage and resistance measurements at V107 socket.

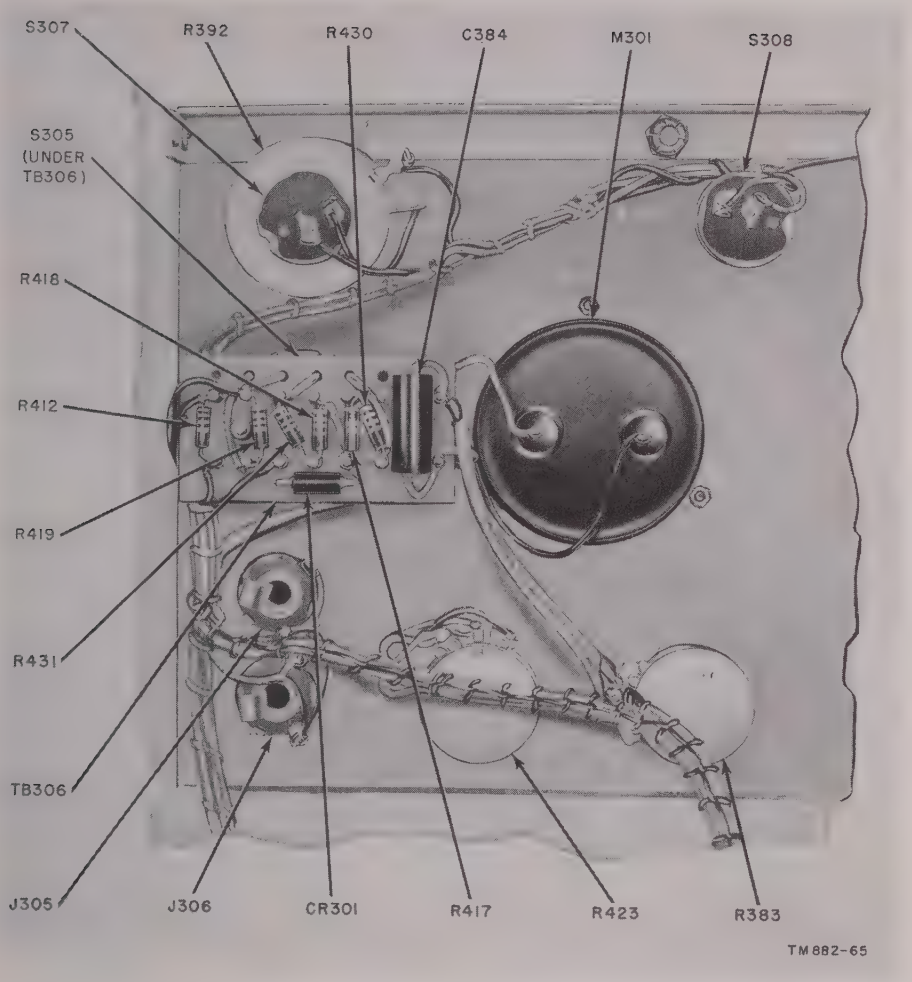


Figure 77. Parts location, main unit, section E.

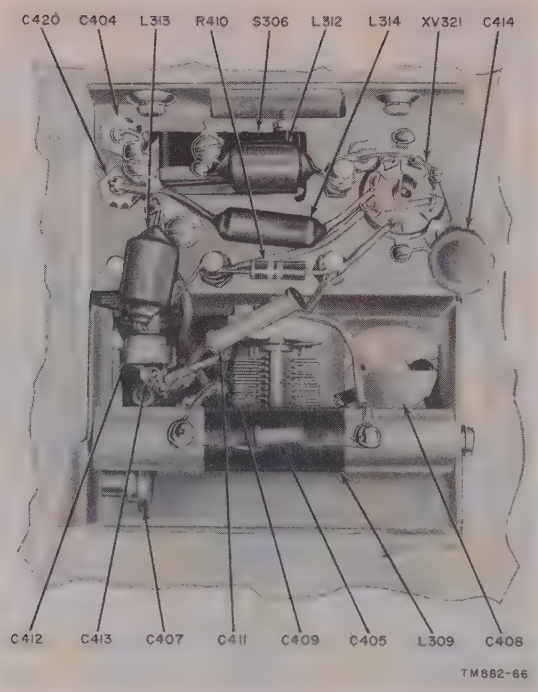


Figure 78. Parts location, main unit, section F.

d. R-f Unit (contd).

Symptom	Probable trouble	Correction
5. Receiver inoperative on all bands.	5*a*. Defective first hfo stage V110.	5*a*. Check voltage and resistance measurements at V110 socket.
	b. Defective third multiplier buffer V103, first mixer V104, third multiplier V106, second multiplier V108, first multiplier V109, or first hfo buffer V116.	*b*. Check voltage and resistance measurements at V103, V104, V106, V108, V109, and/or V116 sockets. If trouble still exists refer to paragraph 95 on signal substitution.
	c. Defective second hfo V111, second mixer V112, and/or first i-f amplifier V113.	*c*. Check voltage and resistance measurements at V111, V112, and/or V113 sockets.
6. Receiver inoperative on one band only.	6*a*. Defective turret coil.	6*a*. Refer to paragraph 94*e*.
	b. Defective component part of T101 and/or T102.	*b*. Refer to voltage and resistance measurements in figures 99 and 100.
	c. Defective crystal in 2d hfo.	*c*. Replace.
7. Receiver output drifts.	7*a*. Open first hfo heating element.	7*a*. Check continuity through heating element; replace if necessary.
	b. Defective S103.	*b*. Replace.

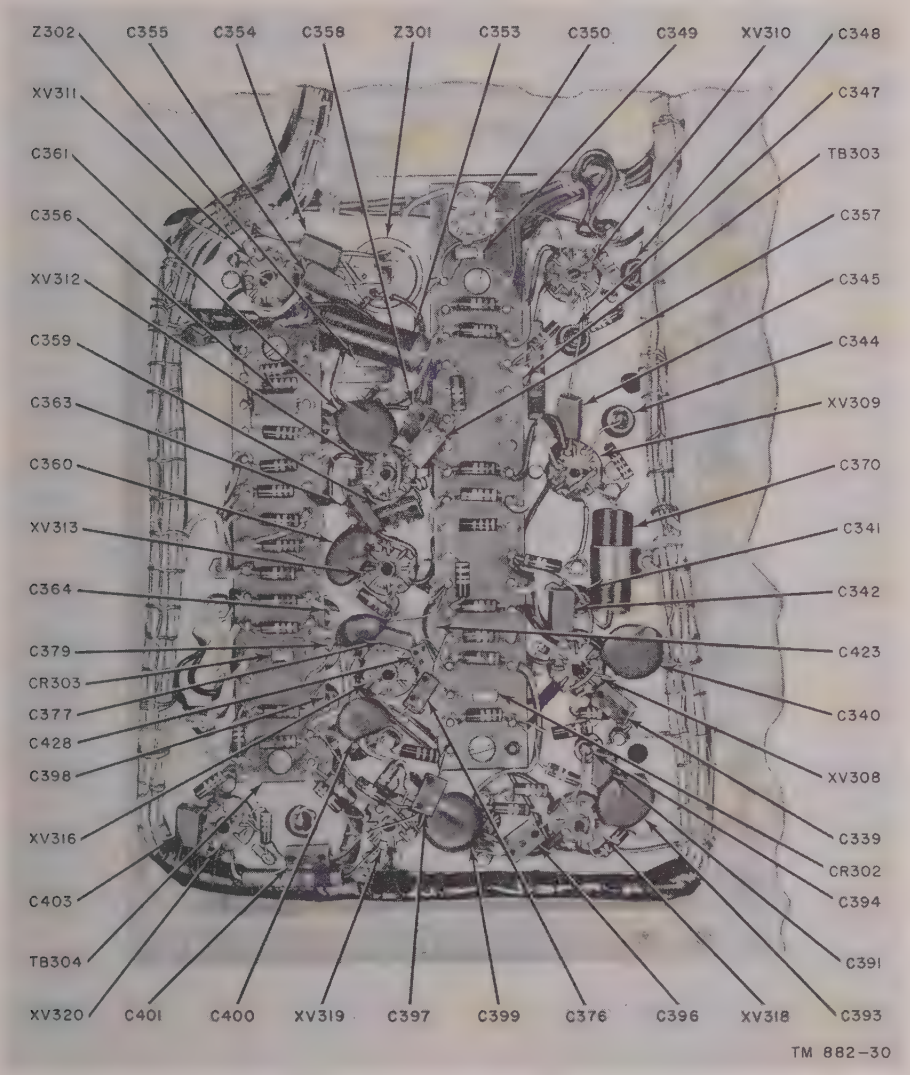


Figure 79. Parts location, main unit, section G, showing capacitors.

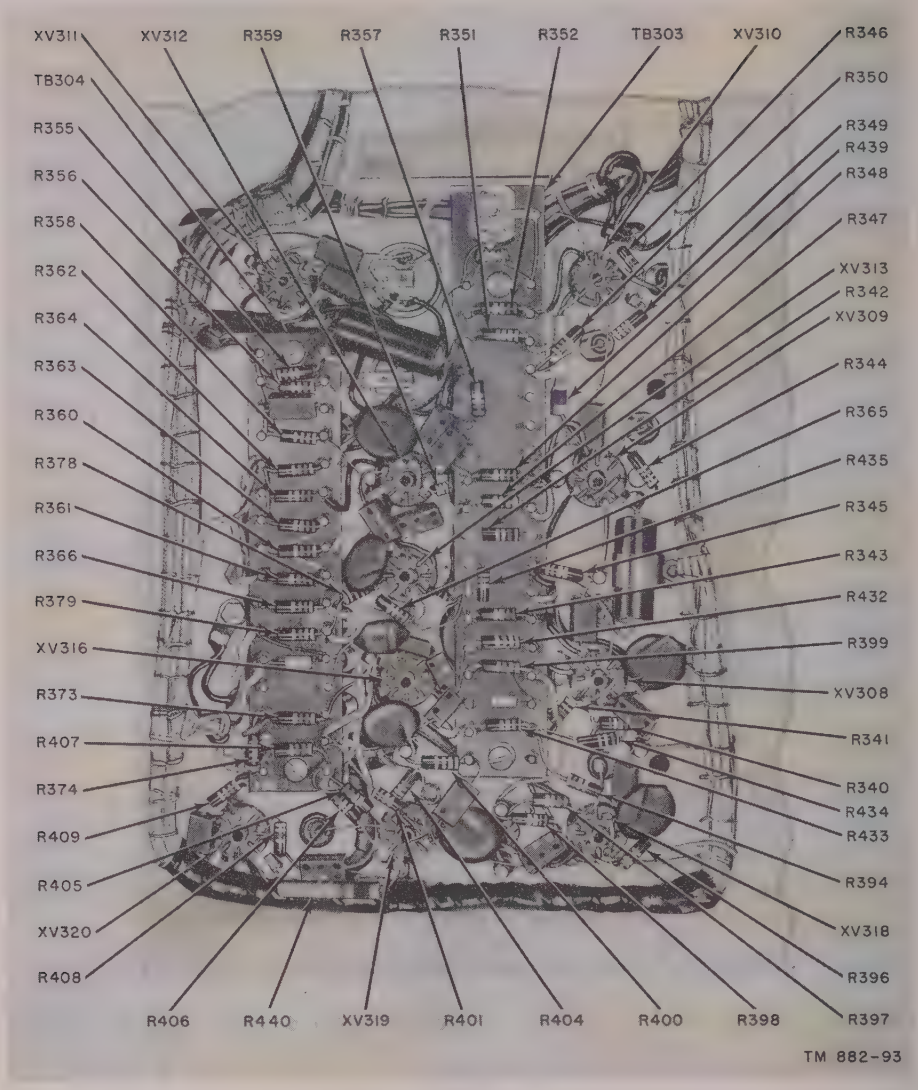


Figure 80. Parts location, main unit, section G, showing resistors.

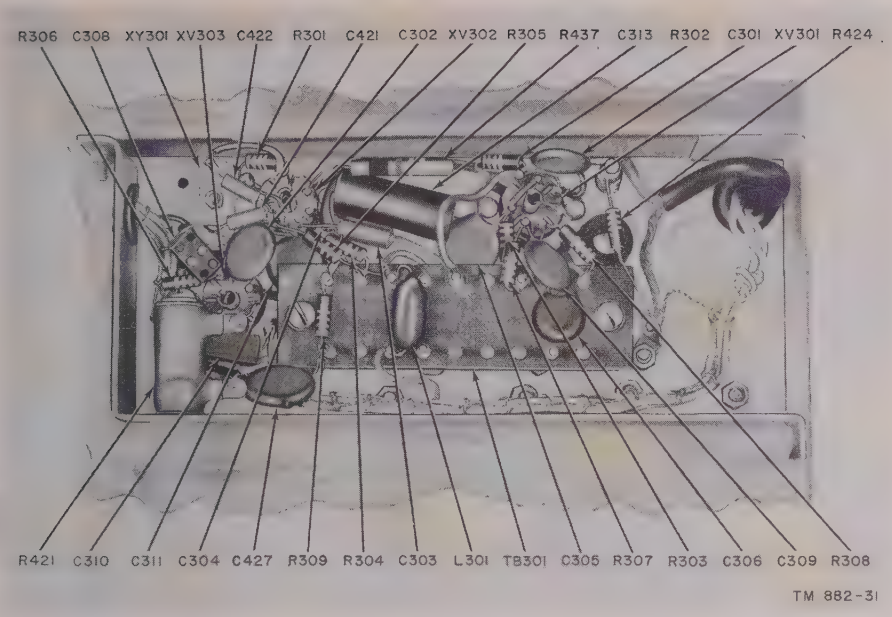


Figure 81. Parts location, main unit, section H.

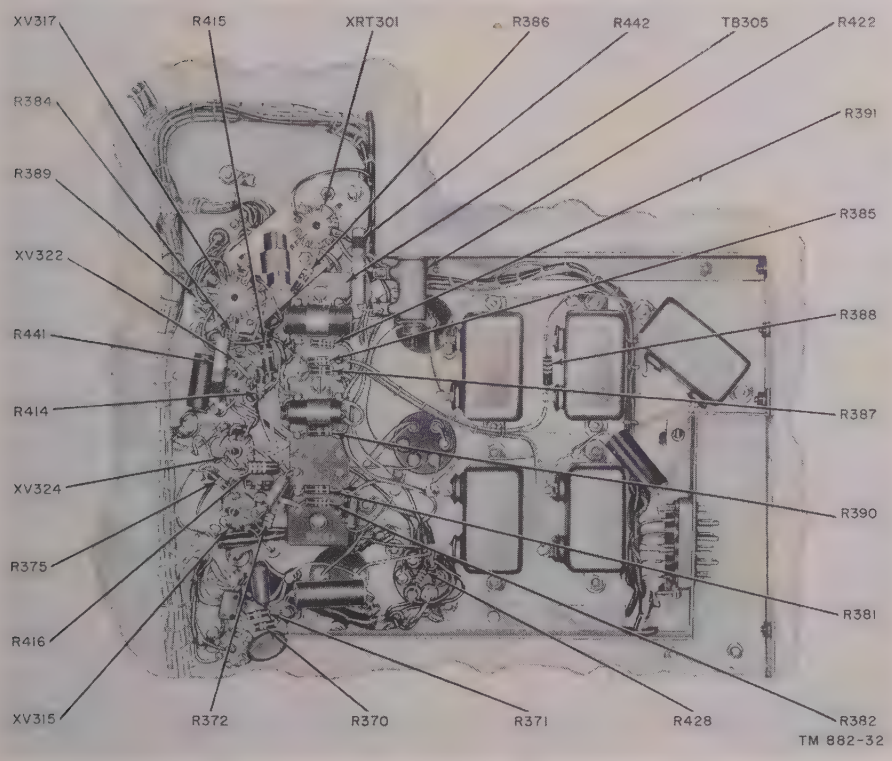


Figure 82. Parts location, main unit, section J, showing resistors.

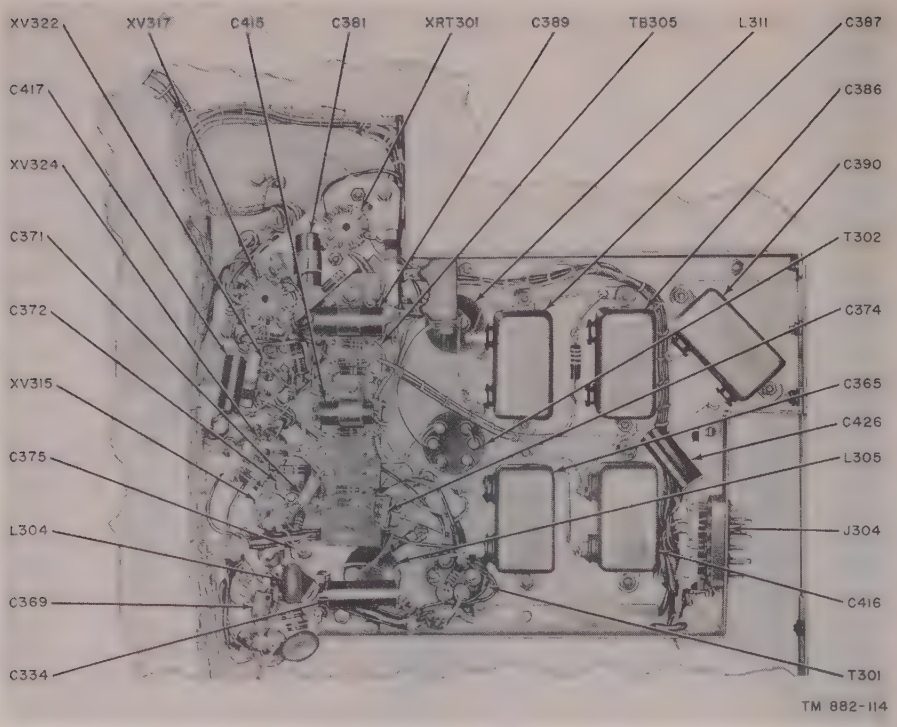


Figure 83. Parts location, main unit, section J, showing capacitors.

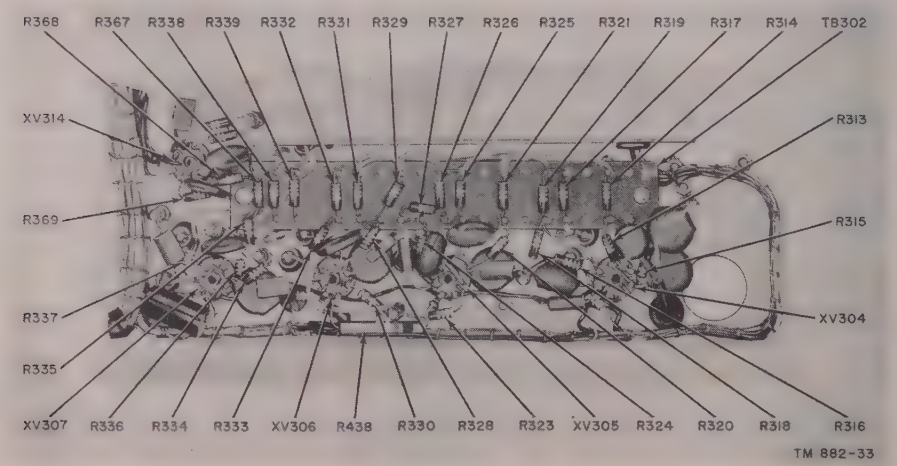


Figure 84. Parts location, main unit, section K, showing resistors.

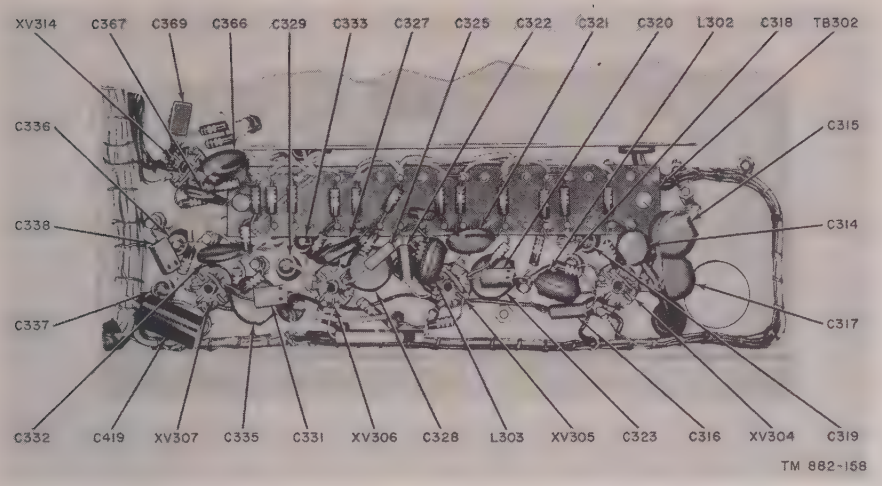


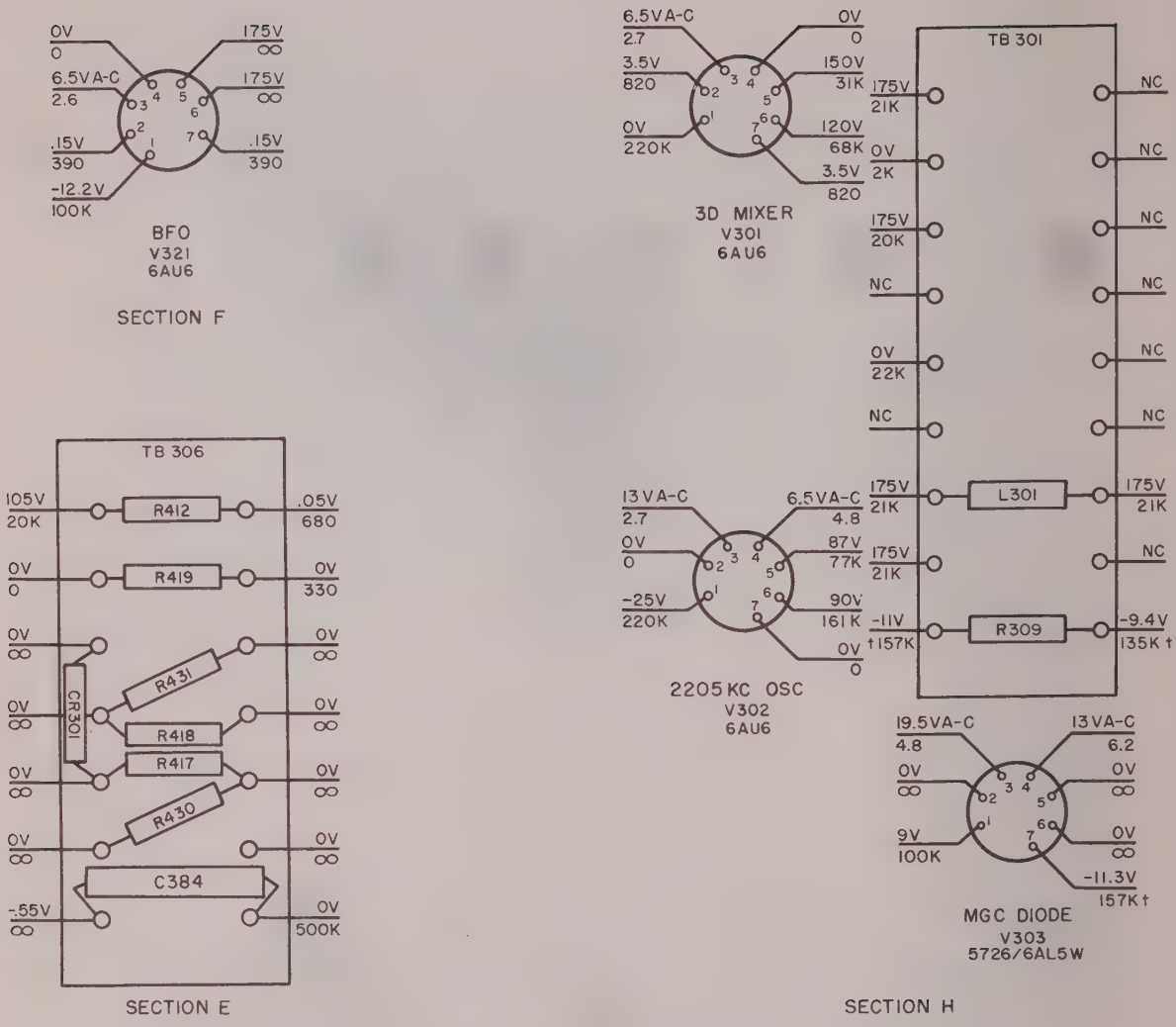
Figure 85. Parts location, main unit, section K, showing capacitors.

d. R-f Unit (contd).

Symptom	Probable trouble	Correction
8. Receiver inoperative on even bands.	8*a*. Defective switch S102.	8*a*. Check for continuity through contacts; replace if necessary.
	b. Even-band oscillator circuit of V110.	*b*. Check; repair or replace.
9. Receiver inoperative on odd bands.	9*a*. Defective switch S102.	9*a*. Check for continuity through contacts; replace if necessary.
	b. Odd-band oscillator circuit of V110.	*b*. Check; repair or replace.
10. Receiver inoperative on bands 2 and 4.	10. Open resistor R166.	10. Replace.

e. Turret Cross-reference Chart.

Turret	Band Number						
	1	2	3	4	5	6	7
Z150	Z101	Z102	Z103	Z104	Z105	Z106	Z107
Z151	Z108	Z109	Z110	Z111	Z112	Z113	Z114
Z152	Z115	Z116	Z117	Z118	Z119	Z120	Z121
Z153	Z122	Z123	Z124	Z125	Z126	Z127	Z128
Z154	Z129	Z130	Z131	Z132	Z133	Z134	Z135
Z155	Z136	Z137	Z138	Z139	Z140	Z141	Z142
Z156	Z143	Z144	Z145	Z146	Z147	Z148	Z149



NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED. * INDICATES MEASUREMENTS MADE WITH A VTVM.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND POWER SUPPLY DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED.
3. ALL MEASUREMENTS MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
OPERATION	MGC
R.F. GAIN SQUELCH	MID-POSITION
B.F. OSCILLATOR	MID-POSITION

4. NC INDICATES NO CONNECTION.
5. † DEPENDS ON SETTING OF R311.

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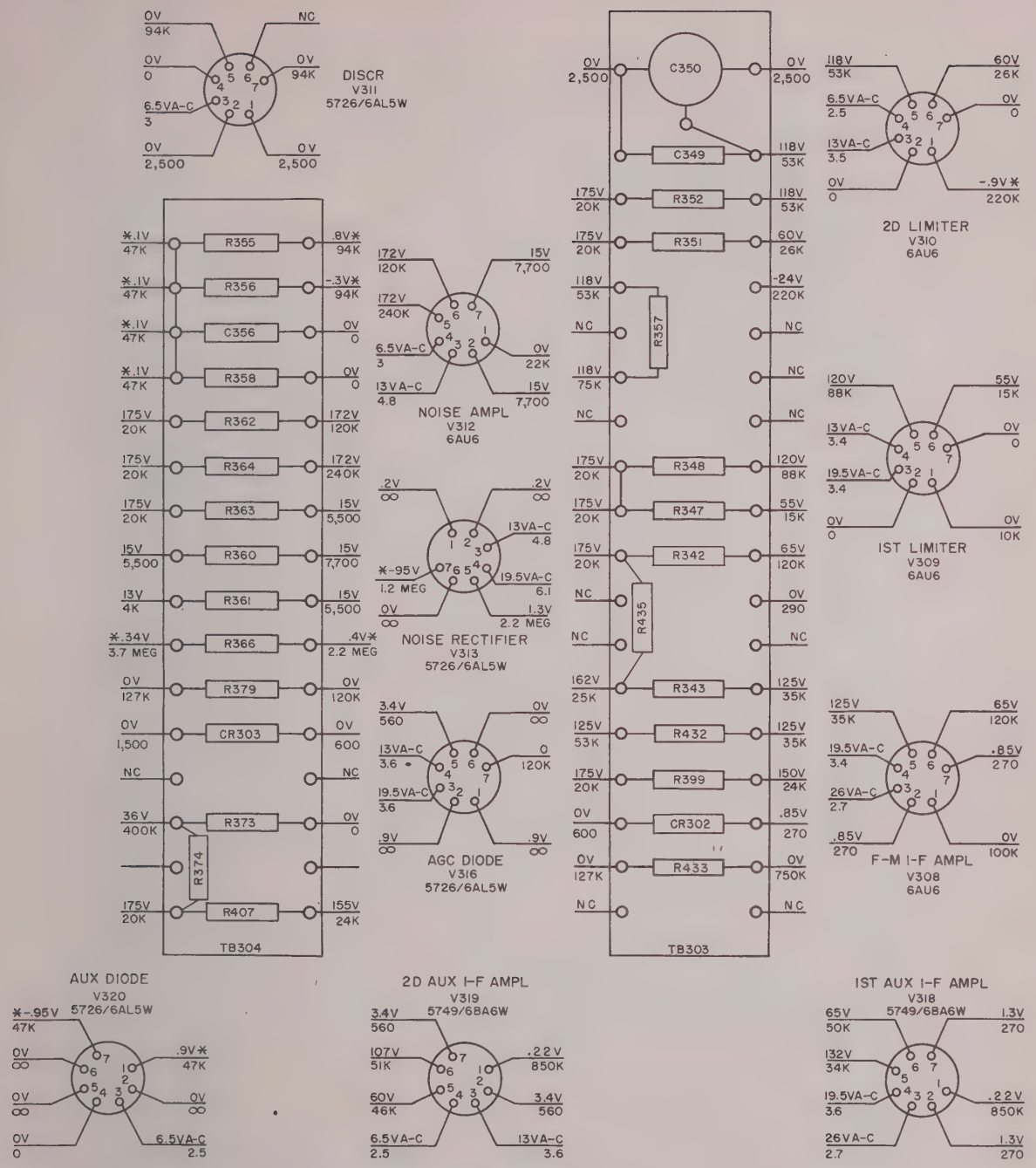
Figure 86. Sections E, F, and H, voltage and resistance measurements.



NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C. POSITIVE MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED. * INDICATES MEASUREMENTS MADE WITH A VTVM.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND POWER SUPPLY DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED.
3. ALL MEASUREMENTS MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
OPERATION	MGC
R.F GAIN SQUELCH	MID-POSITION
DISCR METER CENTER CONTROL	MID-POSITION

4. NC INDICATES NO CONNECTION.

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Figure 87. Section G, voltage and resistance measurements.

NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND POWER SUPPLY DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED.
3. ALL MEASUREMENTS MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
OPERATION	AM SQUELCH
SELECTIVITY	50 K.C.
R.F. GAIN SQUELCH	FULLY CLOCKWISE (SEE NOTE 4)

4. READINGS IN PARENTHESES TAKEN WITH THE R. F. GAIN-SQUELCH CONTROL FULLY COUNTERCLOCKWISE.
5. NC INDICATES NO CONNECTION.

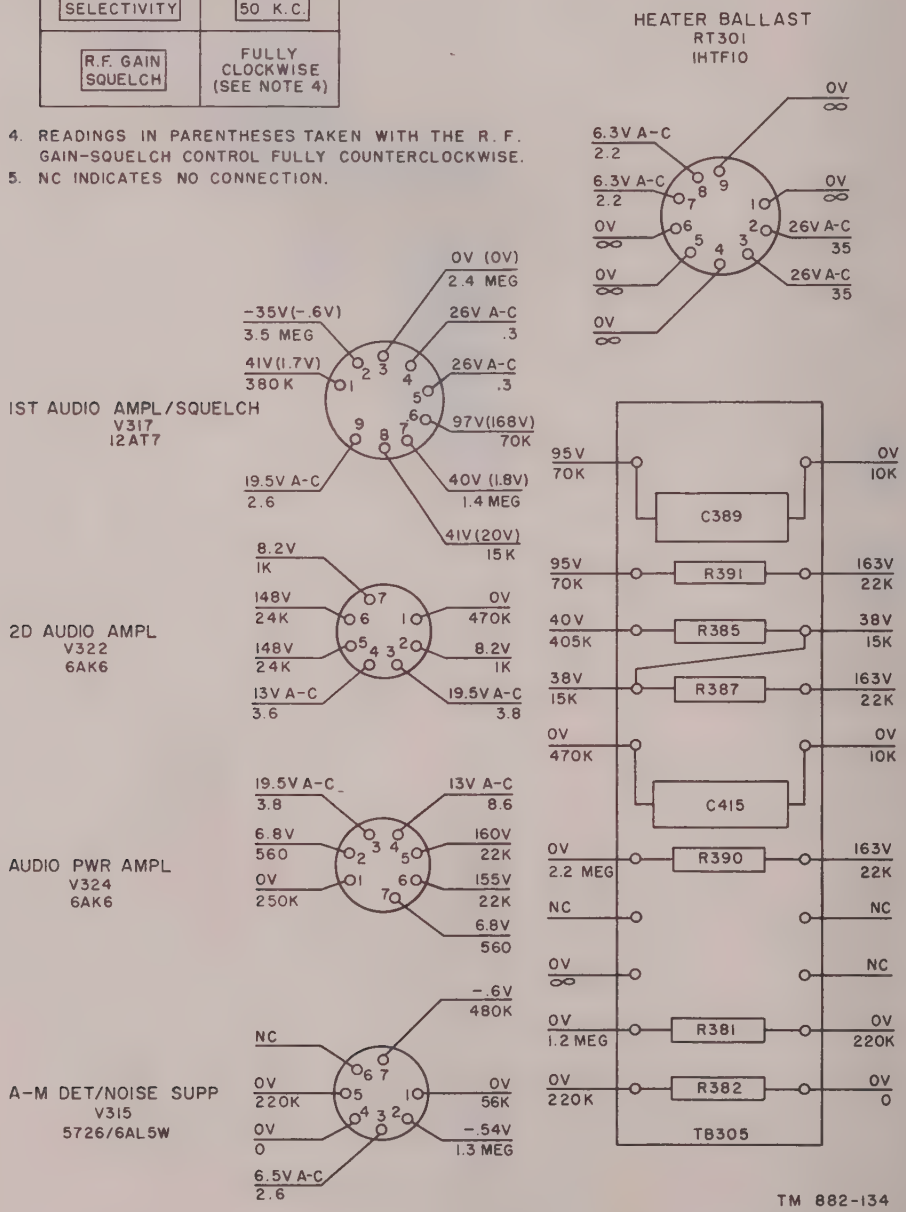

Figure 88. Section J, voltage and resistance measurements.

NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED. ✱INDICATES MEASUREMENTS MADE WITH A VTVM.

2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND POWER SUPPLY DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED.

3. ALL MEASUREMENTS MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
OPERATION	MGC
SELECTIVITY	200 K.C.
R.F GAIN SQUELCH	MID-POSITION

4. NC INDICATES NO CONNECTION.

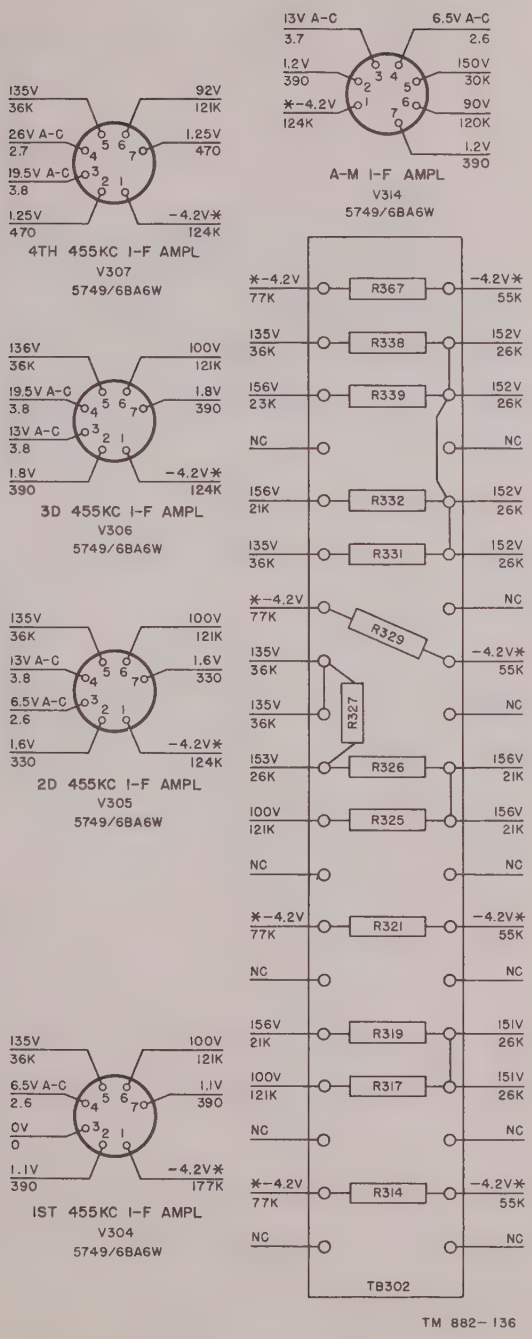

Figure 89. Section K, voltage and resistance measurements.

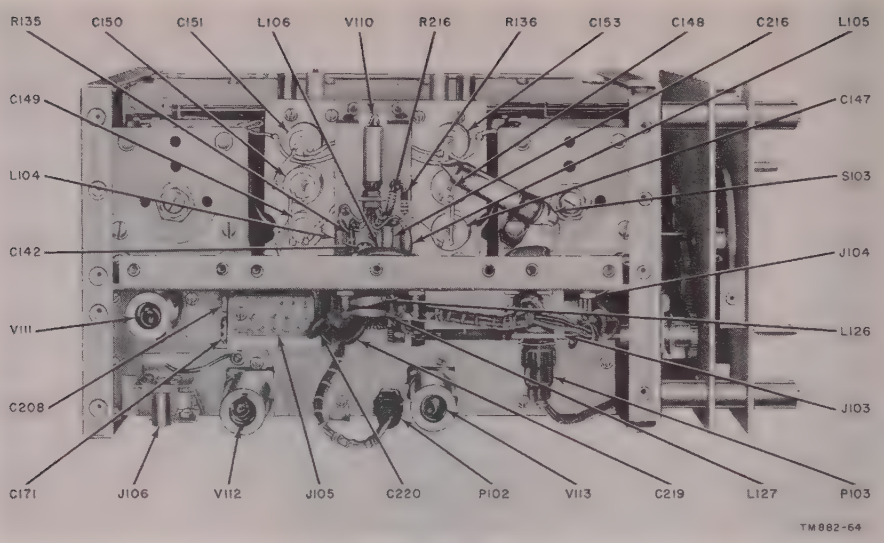

Figure 90. R-f unit, oscillator side.

95. Signal Substitution

When the receiver becomes inoperative, the defect must exist somewhere between the antenna and the speaker. The signal substitution method of trouble shooting quickly isolates a defective stage or circuit. This method of trouble shooting is the process of substituting an externally generated signal for the signal normally present in each stage of the receiver. For example, injecting a 1,000 cycle signal into the audio section of a properly operating receiver results in hearing a 1,000 cycle audio note at the speaker. When checking the i-f section a 455 kc signal, modulated by an audio note, is injected at the grid of one of the i-f amplifier tubes. If that portion of the receiver is operating properly, again an audio note is heard at the speaker. Proper use of the trouble-shooting chart (par. 94) may indicate the approximate location of trouble within the receiver. For this reason, the signal substitution procedures list a separate chart for various sections of the receiver. After determining which section is defective, reference can be made to the appropriate chart of this paragraph, thus eliminating time spent in checking circuits known to be working properly.

a. Signal substitution requires a source of audio, i-f, and r-f signals. Use one of the signal generators listed in paragraph 86 which will produce the signal required in any specific test.

b. A vtvm (vacuum tube voltmeter) and tube tester are needed to isolate the defective component part after the faulty stage has been located. A headset or speaker is also required as an indicating device.

c. Use a capacitor in series with the signal generator lead; .05 uf (microfarad) for audio signals; 100 uuf (micromicrofarad) for i-f and r-f signals.

d. Note the volume obtained; listen for serious distortion. When working back through the receiver from the audio output stage toward the input stages, reduce the signal generator output as required in order to eliminate the possibility of forcing a signal through a defective circuit. If a spare receiver in good operating condition is available, compare the results obtained from the receiver being tested with the receiver known to be operating properly.

e. If the instructions direct a signal injection at a point which is difficult to reach, use another point which is electrically the same, but more accessible.

f. Use extreme care when probing in the receiver. Component parts are small, and wired very close to each other. Check the wiring and the solder connections while testing by signal substitution. A poor solder connection or similar fault may be the trouble.

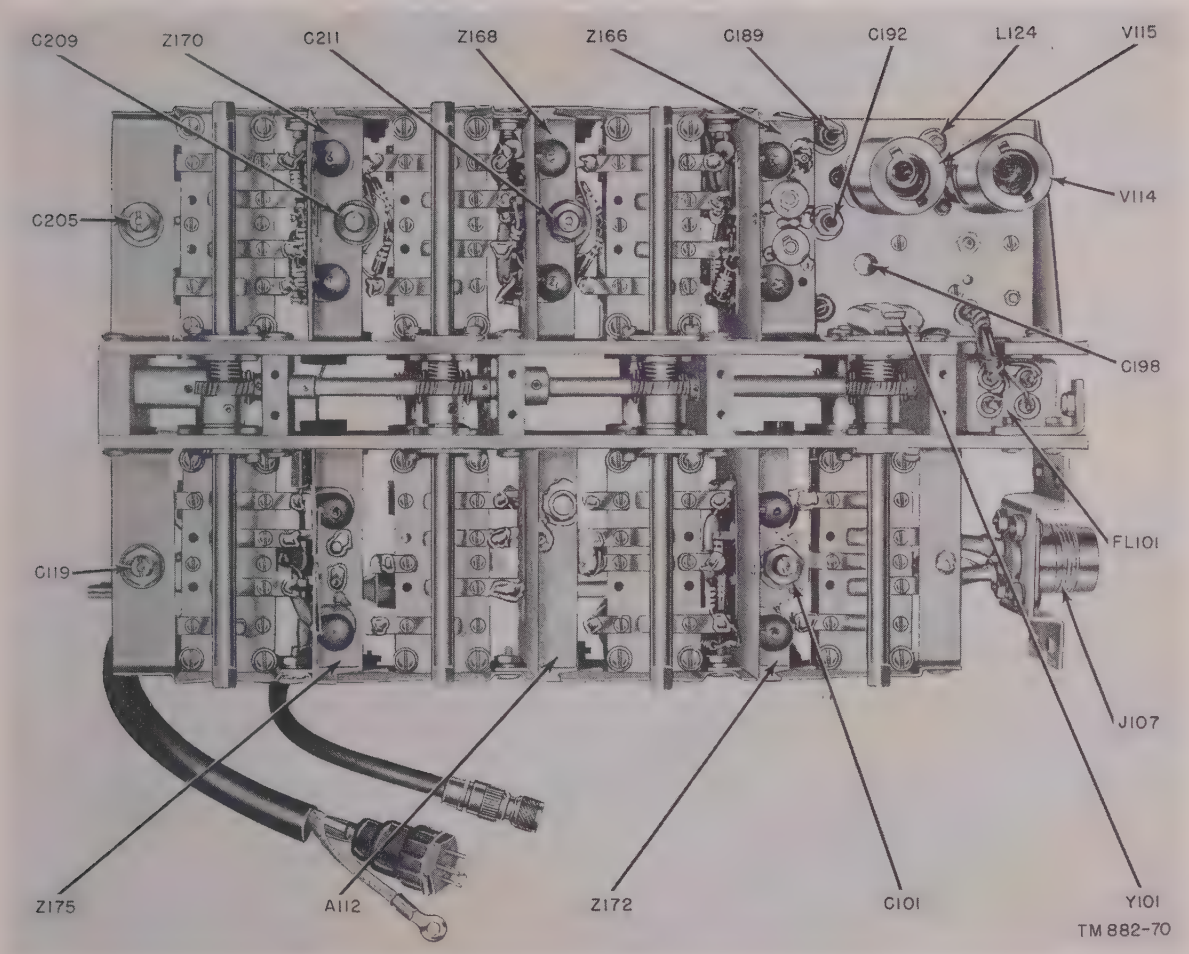

Figure 91. R-f unit, turret side, with turrets removed.

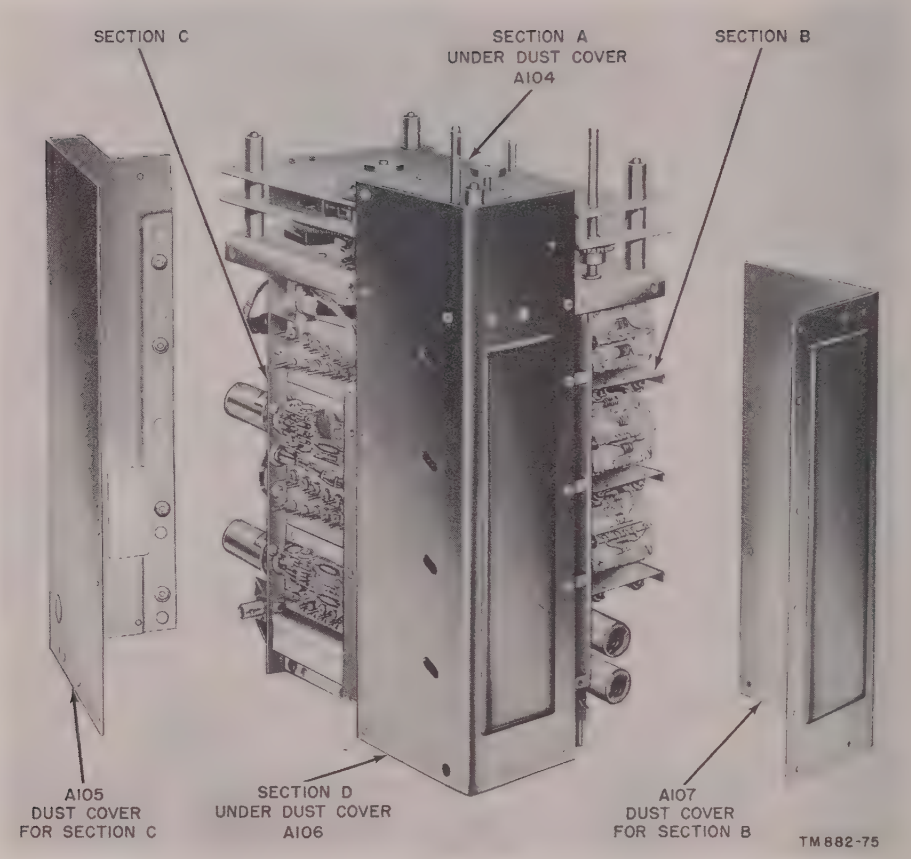

Figure 92. R-f unit, location of sections A through D.

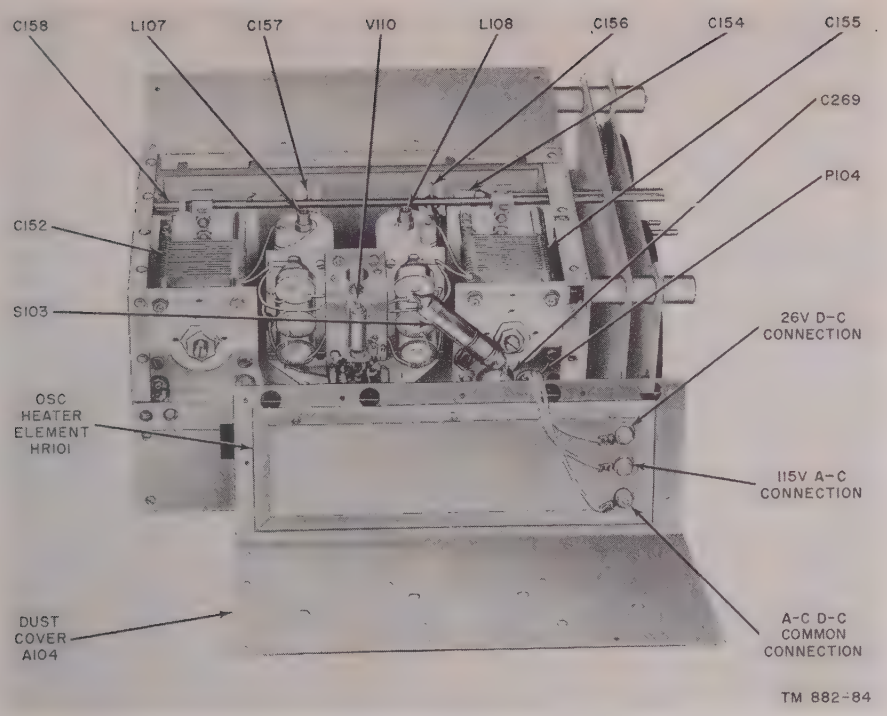

Figure 93. R-f unit, section A.

96. Signal Substitution Charts

Directions for signal substitution are contained in the following charts. Each chart contains specific instructions for a particular section of the receiver; such as the 455–kc i-f and the 1.75–mc i-f. The charts are broken down into three columns. The first, *signal frequency,* lists the frequency required for the test. The second, *connection,* lists a tube pin number or terminal point where the signal is to be applied. The third, *possible defects,* lists those component parts most likely to be defective should the test prove the stage inoperative. If the items listed in the *possible defects* column check good, make voltage and resistance measurements on individual parts of the circuit to determine the trouble.

a. Audio Chart.

Signal frequency	Connection	Possible defects
1 kc	V324, power amplifier grid, pin 1.	Check indicating device (speaker or headset): Check V324; check J305, J306, and connections to same; check continuity of T302, check R423.
1kc	V322, second audio amplifier grid, pin 1.	Check V322; check connections on TB308; check continuity of T301, check C417.
800 cps	V317, first audio amplifier grid, pin 7.	Check V317; check S304, check all settings of S304; check applicable filter if signal is lost on one setting of S304.

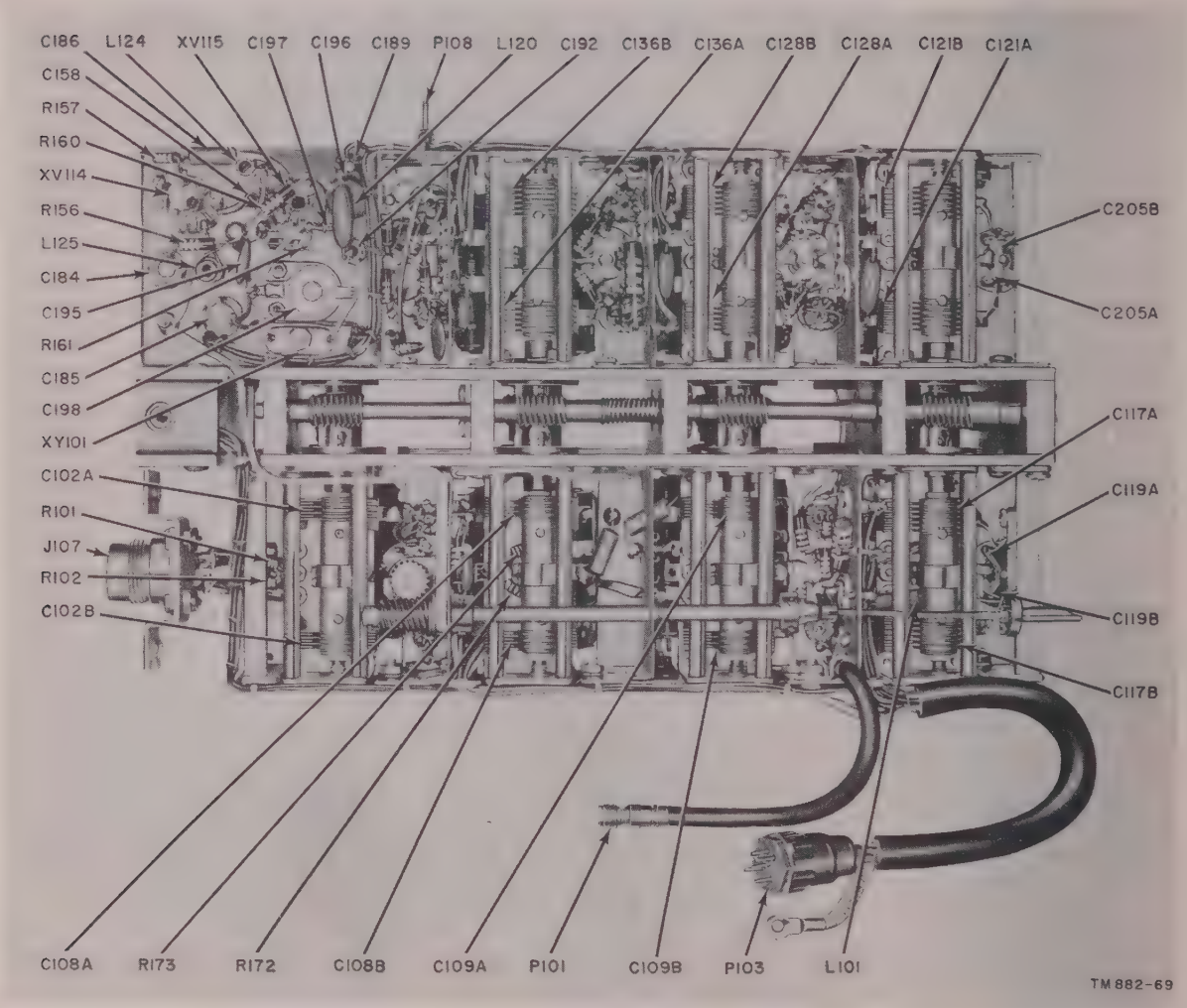

Figure 94. R-f unit, sections B and D.

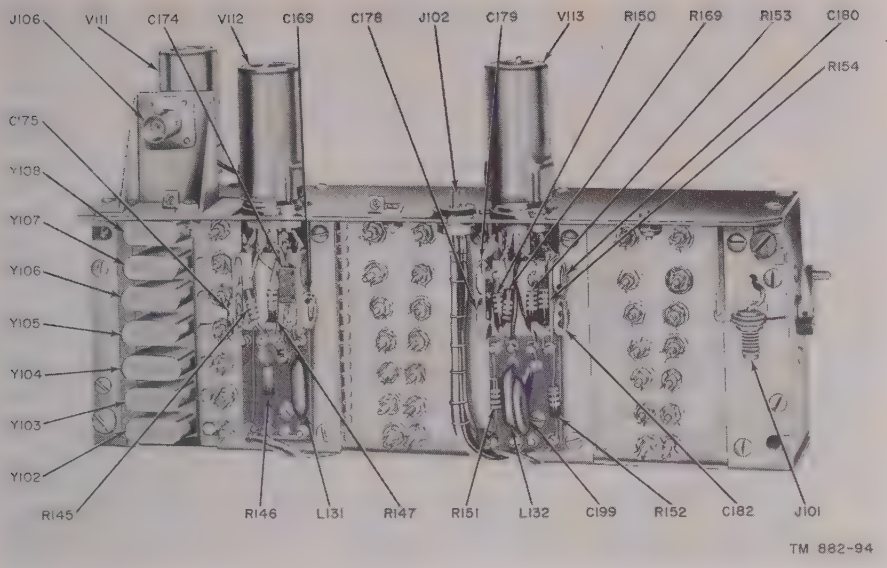

Figure 95. R-f unit, section C, top view.

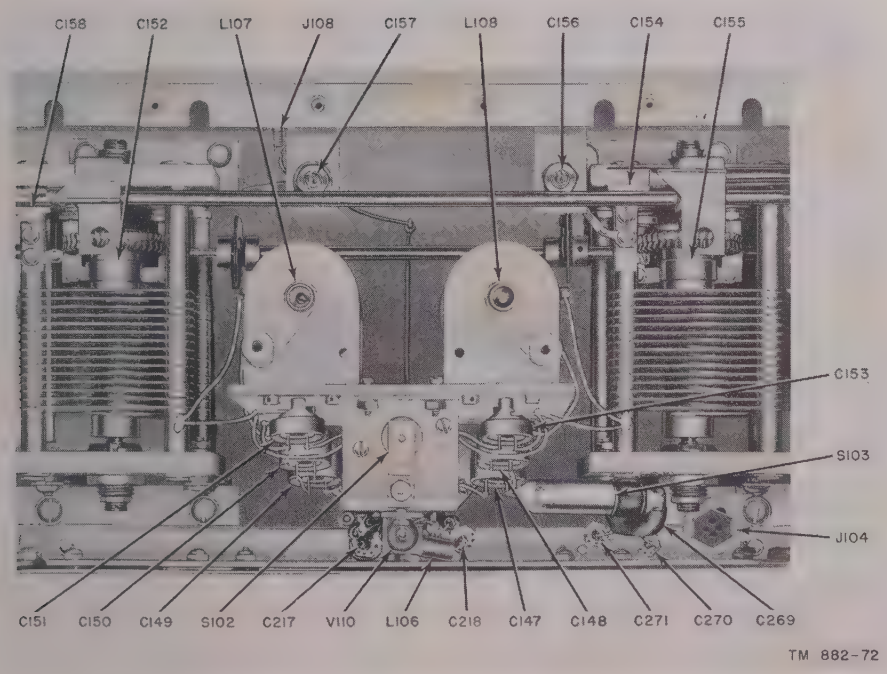

Figure 96. R-f unit, oscillator trimmer assembly.

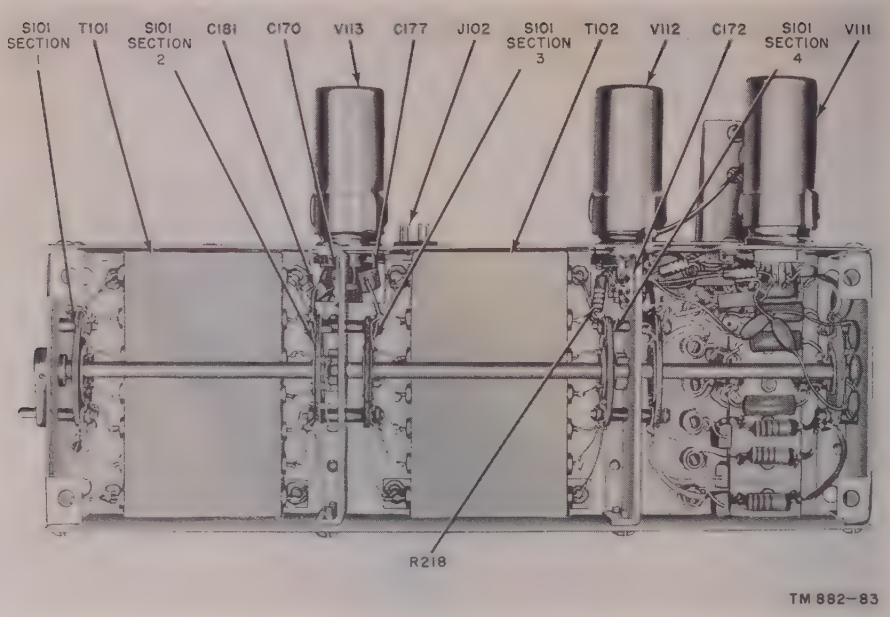

Figure 97. First i-f amplifier, parts location.

b. A-m I-f Chart. This chart is for use when the trouble has been located in the a-m i-f circuit by use of the equipment performance checklist (par. 46).

Signal frequency	Connection	Possible defects
455 kc, a-m	V315A, a-m detector cathode, pin 1.	Check V315; check S303, section 1.
455 kc, a-m	V314, a-m i-f amplifier grid, pin 1.	Check V314; check voltage and resistance measurements at V314 tube socket; check C367, C368.

c. Auxiliary Circuit Chart. This chart is for use when the trouble has been located in the auxiliary circuit by use of the equipment performance checklist (par. 46). The speaker or headset cannot be used as an output indicating device; a vtvm is required. Connect the vtvm between pin 7, V320A and ground, or, connect it between pins A and B of J301.

Signal frequency	Connection	Possible defects
455 kc	V320A, auxiliary diode cathode, pin 1.	Check V320; check voltage and resistance measurements at V320A tube socket.
455 kc	V319, second auxiliary i-f amplifier grid, pin 1.	Check V319; check voltage and resistance measurements at V319 tube socket; check C399, C398, C401, and C402.
455 kc	V318, first auxiliary i-f amplifier grid, pin 1.	Check V318; check voltage and resistance measurements at V318 tube socket; check C393, C394, C396, and C397.

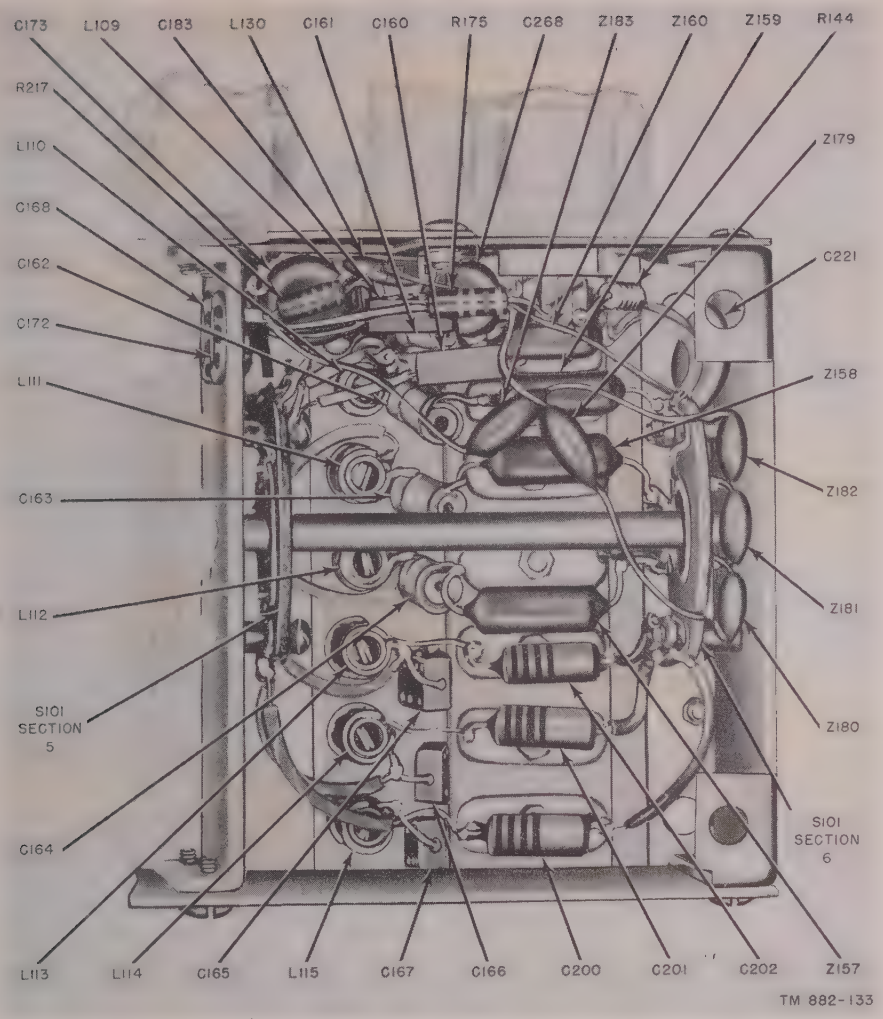

Figure 98. Second hfo, parts location.

d. F-m I-f Chart. This chart is for use when trouble has been located in the f-m i-f circuit by use of the equipment performance checklist (par. 46). The speaker or headset may be used as an indicating device for this test. Set the OPERATION switch to FM SQUELCH.

Signal frequency	Connection	Possible defects
455 kc, f-m	V310, second limiter grid, pin 1.	Check V310; check continuity of L307 and L308; check voltage and resistance measurements at V310 and V311 tube sockets; check C348, C353.
455 kc, f-m	V309, first limiter grid, pin 1.	Check V309; check voltage and resistance measurements at V309 tube socket; check C344 and C345.
455 kc, f-m	V308, f-m i-f amplifier grid, pin 1.	Check V308; check voltage and resistance measurements at V308 tube socket; check C340, C341, and C342.

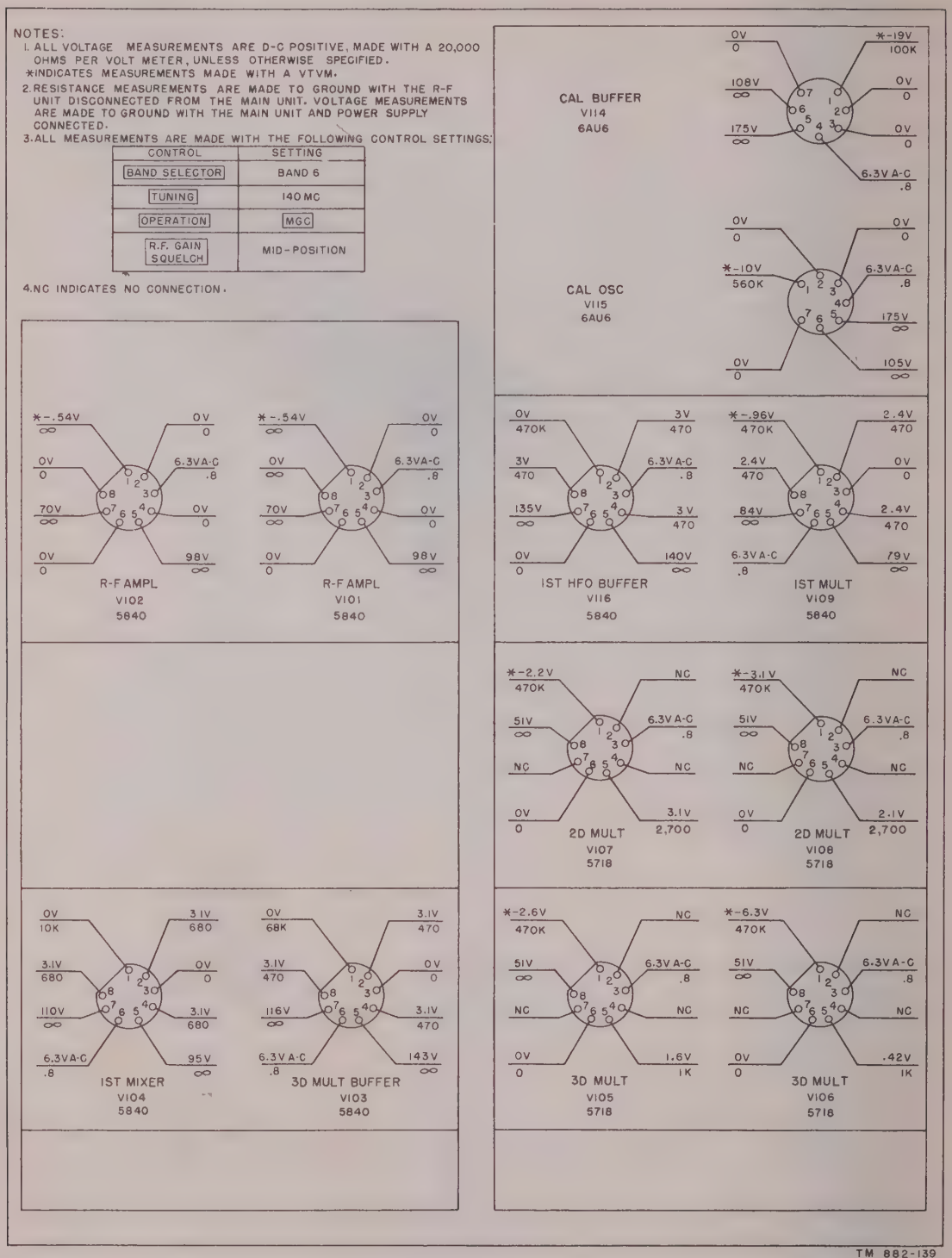
NOTES:
1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED.
*INDICATES MEASUREMENTS MADE WITH A VTVM.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED FROM THE MAIN UNIT. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE MAIN UNIT AND POWER SUPPLY CONNECTED.
3. ALL MEASUREMENTS ARE MADE WITH THE FOLLOWING CONTROL SETTINGS:
CONTROL | SETTING
BAND SELECTOR | BAND 6
TUNING | 140 MC
OPERATION | MGC
R.F. GAIN SQUELCH | MID-POSITION
4. NC INDICATES NO CONNECTION.
CAL BUFFER V114 6AU6
CAL OSC V115 6AU6
R-F AMPL V102 5840
R-F AMPL V101 5840
IST HFO BUFFER V116 5840
IST MULT V109 5840
2D MULT V107 5718
2D MULT V108 5718
IST MIXER V104 5840
3D MULT BUFFER V103 5840
3D MULT V105 5718
3D MULT V106 5718
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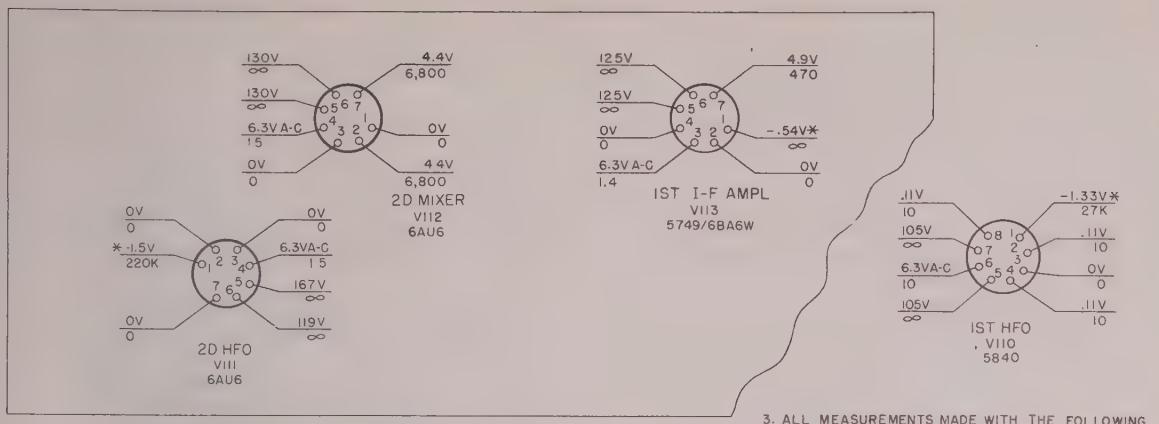
Figure 99. First mixer section, voltage and resistance measurements.



NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED.
   *INDICATES MEASUREMENTS MADE WITH A VTVM.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE MAIN UNIT DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE MAIN UNIT AND POWER SUPPLY CONNECTED.
3. ALL MEASUREMENTS MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
BAND SELECTOR	BAND 1
TUNING	25 MC
OPERATION	MGC
R.F. GAIN SQUELCH	MID-POSITION

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Figure 100. Second mixer and first hfo sections, voltage and resistance measurements.

e. 455 Kc I-f Chart. This chart is for use when the trouble is present for all settings of the OPERATION switch. For this and the remaining tests, set the OPERATION switch to MGC.

Signal frequency	Connection	Possible defects
455 kc, a-m	V307, fourth 455 kc i-f amplifier grid, pin 1.	Check V307; check voltage and resistance measurements at V307 tube socket; check C335, C336, and C337.
455 kc, a-m	V306, third 455 kc i-f amplifier grid, pin 1.	Check V306; check voltage and resistance measurements at V306 tube socket; check C328, C329, C333, and C331.
455 kc, a-m	V305, second 455 kc i-f amplifier grid, pin 1.	Check V305, check continuity of L303; check voltage and resistance measurements at V305 tube socket; check C323, C324, C326, C327, and C325.
455 kc, a-m	V304, first 455 kc i-f amplifier grid, pin 1.	Check V304; check continuity of L302; check voltage and resistance measurements at V304 tube socket; check C317, C318, C319, C321, and C320.
455 kc, a-m	V301, third mixer plate, pin 5.	Check all settings of S301; check applicable filter (FL302, FL303, or FL304) if the signal is lost on one setting of of S301; check C309 and C314 if signal is lost on all settings of S301.
1.75 mc, a-m	V301, third mixer grid, pin 1.	Check V301; check Y301; check voltage and resistance measurements of V302, 2205-kc osc; check C303, C305, C301, and S306.

f. R-f Unit.

(1) *Band 1.* Tune the receiver to 25 mc.

Signal frequency	Connection	Possible defects
6.0942 mc, a-m	V112, second mixer grid, pin 1.	Check V112; check voltage and resistance measurements at V112 socket; check C172, C173, C175, and C174. Check V111; check voltage and resistance measurements at V111 socket; check C183, C221, C160. Check Cable Assembly W301.
6.0942 mc, a-m	V113, first i-f amplifier grid, pin 1.	Check V113; check voltage and resistance measurements at V113 socket; check C177, C178, C179, C180.
6.0942 mc, a-m	V104, first mixer plate, pin 5.	Check voltage and resistance measurements at V104 socket; check connection at P101; check C112, C113, C115 ,C181, S101.
25 mc, a-m	V104, first mixer grid, pin 1.	Check V104; check voltage and resistance measurements at V104 socket.
25 mc, a-m	V101, r-f amplifier plate, pin 5.	Check Z108, Z115; check voltage and resistance measurements at V101 and V102 sockets.
25 mc, a-m	V101, r-f amplifier grid, pin 1.	Check V101; check voltage and resistance measurements at V101 socket; check C105, C103, and C106.
25 mc, a-m	Antenna input jack J107.	Check connections at J107; check Z101; check V102.

(2) *Band 2.* Tune the receiver to 35 mc.

Signal frequency	Connection	Possible defects
8.6369 mc, a-m	V113, first i-f amplifier grid, pin 1.	Check L158, L159, C246, and/or C247; check S101.
8.6369 mc, a-m	V104, first mixer plate, pin 5.	Check L144, L145, C232, and/or C233; check S101.
35 mc, a-m	V101, r-f amplifier plate, pin 5.	Check Z109 and Z116.
35 mc, a-m	Antenna input jack J107.	Check Z102.

(3) *Band 3.* Tune the receiver to 50 mc.

Signal frequency	Connection	Possible defects
12.1884 mc, a-m	V113, first i-f amplifier grid, pin 1.	Check L156, L157, C244, and/or C245; check S101.
12.1884 mc, a-m	V104, first mixer plate, pin 5.	Check L142, L143, C230, and/or C231; check S101.
50 mc, a-m	V101, r-f amplifier plate, pin 5.	Check Z110 and Z117.
50 mc, a-m	Antenna input jack J107.	Check Z103.

(4) *Band 4.* Tune the receiver to 65 mc.

Signal frequency	Connection	Possible defects
17.2738 mc, a-m	V113, first i-f amplifier grid, pin 1.	Check L154, L155, C242, and/or C243; check S101.
17.2738 mc, a-m	V104, first mixer plate, pin 5.	Check L140, L141, C228, and/or C229; check S101.
65 mc, a-m	V101, r-f amplifier plate, pin 5.	Check Z111 and Z118.
65 mc, a-m	Antenna input jack J107.	Check Z104.

(5) *Band 5.* Tune the receiver to 95 mc.

Signal frequency	Connection	Possible defects
24.3767 mc, a-m	V113, first i-f amplifier grid, pin 1.	Check L152, L153, C240, and/or C241; check S101.
24.3767 mc, a-m	V104, first mixer plate, pin 5.	Check L138, L139, C226, and/or C227; check S101.
95 mc, a-m	V101, r-f amplifier plate, pin 5.	Check Z112 and Z119.
95 mc, a-m	Antenna input jack J107.	Check Z105.

(6) *Band 6.* Tune the receiver to 130 mc.

Signal frequency	Connection	Possible defects
34.5476 mc, a-m	V113, first i-f amplifier grid, pin 1.	Check L150, L151, C238, and/or C239; check S101.
34.5476 mc, a-m	V104, first mixer plate, pin 5.	Check L136, L137, C224, and/or C225; check S101.
130 mc, a-m	V101, r-f amplifier plate, pin 5.	Check Z113 and Z120.
130 mc, a-m	Antenna input jack J107.	Check Z106.

(7) *Band 7.* Tune the receiver to 200 mc.

Signal frequency	Connection	Possible defects
48.7535 mc, a-m	V113, first i-f amplifier grid, pin 1.	Check L148, L149, C236, and/or C237; check S101.
48.7535 mc, a-m	V104, first mixer plate, pin 5.	Check L134, L135, C222, and/or C223; check S101.
200 mc, a-m	V101, r-f amplifier plate, pin 5.	Check Z114 and Z121.
200 mc, a-m	Antenna input jack J107.	Check Z107.

97. Stage Gain Chart

a. General. The stage gain chart and oscillator injection voltage chart of this paragraph are primarily intended to aid in localizing the defect when low sensitivity is encountered. In the stage gain chart the nominal input value is the amount of signal required to produce 200 mw of output. The nominal value will vary from one receiver to another even with normally operating equipment. An appreciable difference between the value given in the chart and the observed value indicates a defect. After the defective stage has been localized, refer to the voltage and resistance diagrams for aid in isolating the defective component part. The oscillator injection voltage chart lists the amount of injection voltage that should be present at the cathode of the first mixer stage V104. If no reading is observed trouble shooting will be necessary. If a lower than normal reading is observed alinement of the first hfo and multipliers may be necessary.

b. Procedure. Connect the applicable signal generator between the point indicated in the stage gain chart and ground. Suitable equipment is listed in paragraph 86. For protection to the signal generator, place a .05-uf capacitor in series with the ungrounded lead. The output of the r-f signal generator should be amplitude modulated 30 percent at 400 cycles. Connect the output meter between terminals 1 and 2 of TB308. When making stage gain measurements always adjust the signal generator output to obtain 200 mw of audio output. Compare the amount of signal generator output with the nominal value listed in the chart. If there is an appreciable difference, consider the stage defective. When measuring the oscillator injection voltage connect a vtvm to the cathode (pin 2) of first mixer V104 and ground.

c. Control Settings. Unless otherwise specified set the receiver front panel controls to the following positions:

(1) BAND SELECTOR to band 1.

(2) TUNING to 20 mc.

(3) B.F. OSCILLATOR to OFF.

(4) SELECTIVITY to 200 K.C.

(5) AUDIO RESPONSE to MEDIUM.

(6) R.F. GAIN–SQUELCH to approximate mid- position.

(7) AUDIO GAIN 1 and AUDIO GAIN 2 fully clockwise.

(8) NOISE LIMITER to OFF.

(9) OPERATION to MGC.

(10) METER switch to CARRIER.

(11) CALIBRATE to OFF.

d. Stage Gain Measurements.

Frequency	Applied to		Nominal input value
	Pin	Tube	
400 cps	1	V324	7.1 v
	1	V322	.83 v
	7	V317B	.035 v
	7	V315A	.04 v
455 kc a-m	1	V315A	260,000 uv
	1	V314	65,000 uv
	1	V307	15,000 uv
	1	V306	2,400 uv
	1	V305	320 uv
	1	V304	45 uv
SELECTIVITY switch in the 200 K.C. position.	5	V301	32 uv
SELECTIVITY switch in the 50 K.C. position.	5	V301	185 uv
SELECTIVITY switch in the 10 K.C. position.	5	V301	290 uv

Frequency	Applied to		Nominal input value
	Pin	Tube	
SELECTIVITY switch in the 200 K.C. position.	1	V301	22 uv
SELECTIVITY switch in the 50 K.C. position.	1	V301	20 uv
SELECTIVITY switch in the 10 K.C. position.	1	V301	20 uv
1.75 mc a-m	1	V112	55 uv
6.0942 mc a-m (band 1)	1	V112	45 uv
8.6369 mc a-m (band 2)	1	V112	70 uv
12.1884 mc a-m (band 3)	1	V112	35 uv
17.2738 mc a-m (band 4)	1	V112	30 uv
24.3767 mc a-m (band 5)	1	V112	35 uv
34.5476 mc a-m (band 6)	1	V112	35 uv
48.7535 mc a-m (band 7)	1	V112	40 uv
6.0942 mc a-m (band 1)	1	V113	60 uv
8.6369 mc a-m (band 2)	1	V113	95 uv
12.1884 mc a-m (band 3)	1	V113	45 uv
17.2738 mc a-m (band 4)	1	V113	40 uv
24.3767 mc a-m (band 5)	1	V113	9 uv
34.5476 mc a-m (band 6)	1	V113	7 uv
48.7535 mc a-m (band 7)	1	V113	8 uv
6.0942 mc a-m (band 1)	1	V104	55 uv
8.6369 mc a-m (band 2)	1	V104	55 uv
12.1884 mc a-m (band 3)	1	V104	28 uv
17.2738 mc a-m (band 4)	1	V104	17 uv
24.3767 mc a-m (band 5)	1	V104	5.7 uv
34.5476 mc a-m (band 6)	1	V104	2.2 uv
48.7535 mc a-m (band 7)	1	V104	6.5 uv
20 mc a-m (band 1)	1	V104	79 uv
29 mc a-m (band 2)	1	V104	90 uv
40 mc a-m (band 3)	1	V104	41 uv
57 mc a-m (band 4)	1	V104	41 uv

d. Stage Gain Measurements (contd).

Frequency	Applied to		Nominal input value
	Pin	Tube	
80 mc a-m (band 5)	1	V104	11.5 uv
114 mc a-m (band 6)	1	V104	3.8 uv
160 mc a-m (band 7)	1	V104	14.5 uv

e. Oscillator Injection Voltage.

Band	Frequency (mc)	Injection voltage (volts)	Band	Frequency (mc)	Injection voltage (volts)
1	20	1.67	5	81	1.5
	29	2.25		116	1.78
2	28.5	1.43	6	115	1.53
	41	3.0		164	1.97
3	40	1.82	7	160	1.04
	58	2.20		232	1.63
4	57	1.08			
	82	2.57			

Section II. REPAIRS

98. Replacement of Parts

Most of the component parts in the main unit and power supply are readily accessible and may easily be replaced. However, in order to replace certain component parts in the r-f unit, disassembly is necessary. When repair of Radio Receiving Set AN/URR–29 is required, follow the disassembly procedures outlined in paragraphs 99 through 104. When replacement of parts is necessary, observe the following precautions.

a. Tagging Leads. Tagging leads is essential to assure correct rewiring when a part is replaced. Small tags or short pieces of adhesive tape will identify all wires in accordance with their connections. Identify every lead to be removed.

b. Parts and Substitutions. When damaged parts must be replaced, identical parts should be used. If identical parts are not available and the damaged component is beyond repair, a substitution must be made. The part substituted must be approximately the same *physical* size and have equal or higher voltage and current ratings.

c. Location. Locate replaced or substituted parts in exactly the same position as that formerly occupied by the defective part. Changing the position of parts or leads, especially in the r-f unit, will affect tuning and alinement.

d. Mounting. Mount the replaced or substituted part in the same mounting as that formerly occupied by the defective part. Fasten all mountings securely.

e. Soldering. Before soldering any connections, carefully scrape all parts that will be touched by the solder until all traces of rust, corrosion, paint, or varnish are removed. Remove the scrapings with a small clean brush. Tin all surfaces to be soldered. Wrap the wire around the lug to obtain mechanical support. Use a small amount of solder to make the connection and use sufficient heat to make the solder flow evenly around the tinned surfaces.

f. Retropicalization. If the parts to be replaced require special treatment, such as retropicalization, follow the instructions given in TB SIG 13 Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

99. Disassembly of R-f Unit

a. General. The r-f unit is made up of three major sections; the first hfo section, the first mixer section, and the second mixer section. The control head is connected to the front of the r-f unit and mechanical connections are made from it to each of the major sections. Therefore, it is important that no adjustment of any of the controls be made once the control head is disconnected from the r-f unit, or complete realinement will be necessary. Rotate the BAND SELECTOR control to band 4. Remove the r-f unit from the receiver by following the instructions in paragraph 17. Instructions for the removal of the dust covers, which enclose the r-f unit, will also be found in paragraph 17.

b. Removal of Rear Cover.

(1) Remove the four #4 flathead screws holding the rear cover to the frame.

(2) Remove the four #6 flathead screws which retain the antenna input connector bracket.

(3) Remove the rear cover.

c. Removal of Second Mixer Section (figs. 101 and 118).

(1) Disconnect second mixer section power plug J102.

(2) Disconnect coaxial cable connector P101 from J101.

(3) Loosen the four captivated screws at the corners of the second mixer section (fig. 118).

(4) Tilt the back of the chassis up and then draw the assembly up away from the baseplate.

(5) Replace the second mixer section by reversing the above procedure.

d. Removal of First Mixer Section (figs. 101 and 102).

(1) Disengage coaxial cable connector P101 of the first mixer section from jack J101 of the second mixer section.

(2) Disconnect P108 from J108 of the first hfo section by using a long thin screw driver to pry up on the shoulder of the plug (fig. 102).

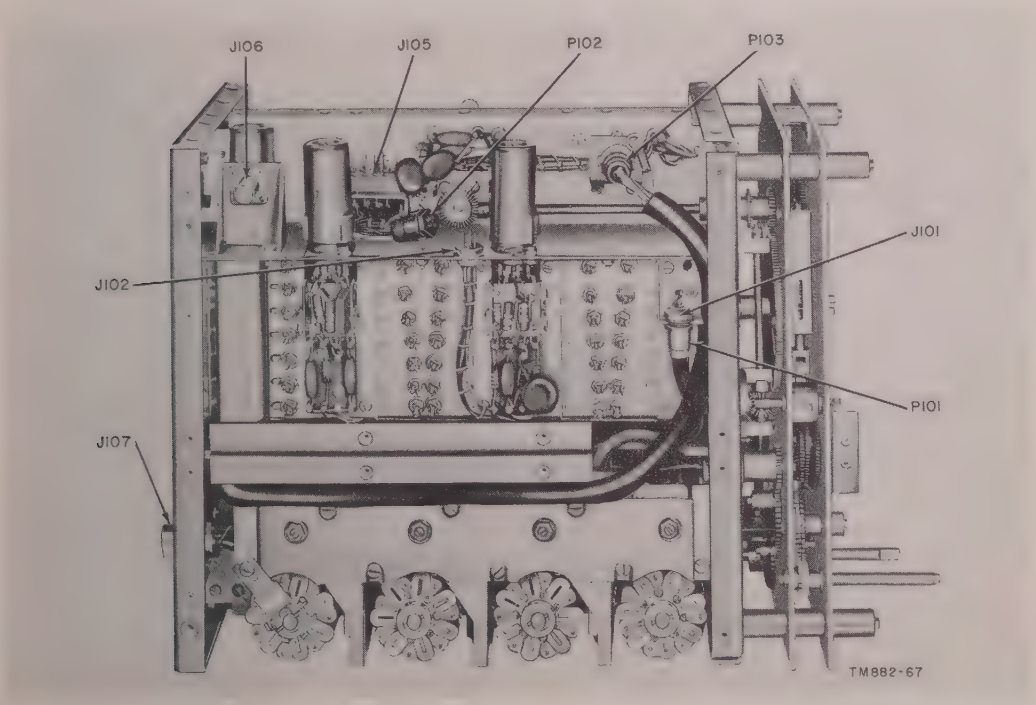

Figure 101. R-f unit, bottom view.

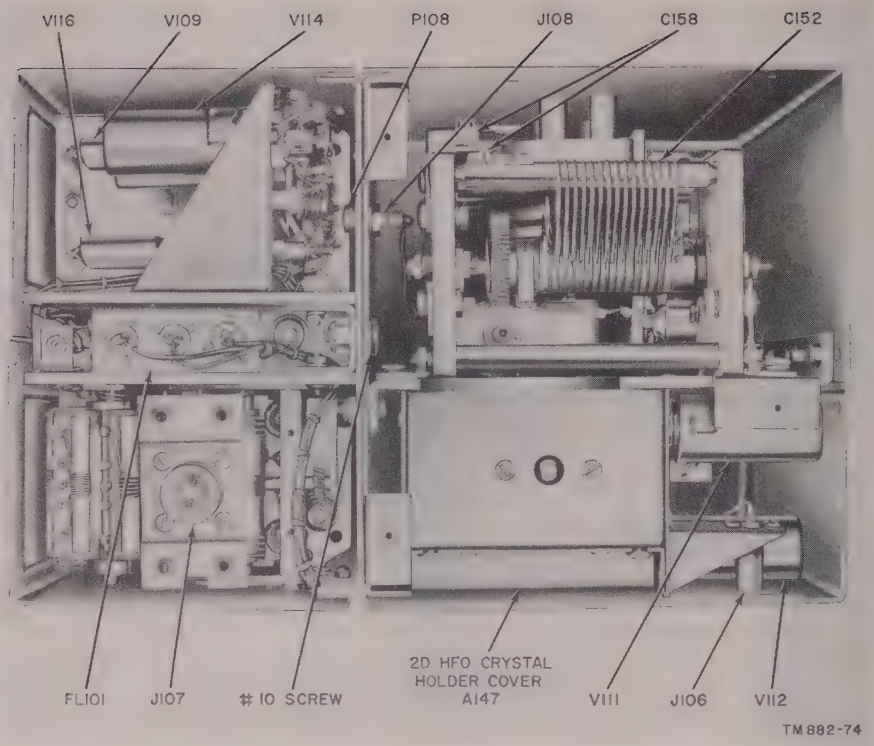

Figure 102. Radio Receiver R–220/URR, r-f unit, rear view.

(3) Remove plug P103 from jack J103. Bend the cable clamp which holds the power cable to the control head bearing plate and pull the cable out so that it is hanging free.

(4) Remove the #10 screw that fastens the rear of the first mixer section to the frame of the r-f unit.

(5) Remove the #6 screw that holds the front of the first mixer section to the control head bearing plate.

(6) The first mixer section may now be removed from the r-f unit by sliding it back and away from the baseplate.

(7) Replacement of the first mixer section is accomplished by reversing the procedure above.

100. Control Head Disassembly

(figs. 103, 104, 105, 130, and 131)

a. General. The control head of Radio Receiver R–220/URR consists of various gear assemblies which are used to continuously tune the receiver to any frequency within the range of 20 to 230 mc. An over-all view of the control head is shown in figure 103. The various parts of the control head are mounted on control plate #1 assembly (AA), control bearing plate #2 assembly (BB), and control bearing frame #3 assembly (CC). Figure 104 shows the assemblies located between control bearing plate #1 and control bearing plate #2 (assemblies A through L) ; an exploded view of these assemblies is shown in figure 130. Figure 105 shows the assemblies located between control bearing plate #2 and control bearing frame #3 (assemblies M through X) ; an exploded view of these assemblies is shown in figure 131. Parts shown in figures 103, 104, 105, 130, and 131 are identified by a letter or a letter and number combination. When following the disassembly procedure refer to figures 103, 104, and 105 to locate the assembly; then to figures 130 and 131 to locate individual parts of the assembly.

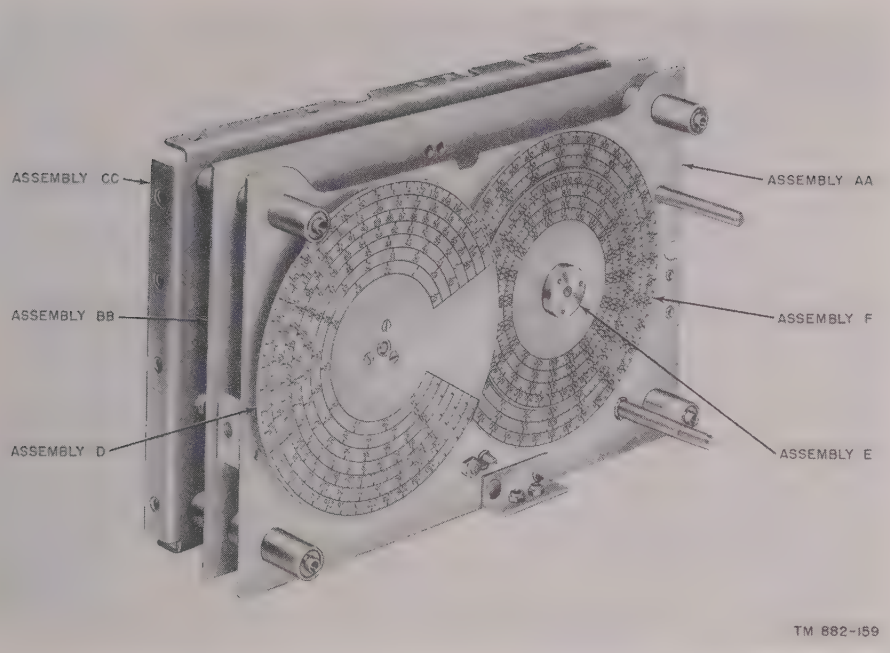

Figure 103. Control head, over-all view.

b. Partial Disassembly (figs. 103, 104, and 105). The control head parts are mounted on control bearing plate #1 assembly (AA); control bearing plate #2 assembly (BB); and control bearing frame #3 assembly (CC). The procedure for partial disassembly is outlined below.

(1) Rotate vernier drive shaft B5 clockwise until the mechanical stop is reached. This occurs when main dial stop stud A 4 comes in contact with main dial stop C5.

(2) Remove four hex nuts DD6 and four lockwashers DD5 at the rear corners of control bearing frame #3 CC1.

(3) Remove the twelve bearing plate spacer posts DD2, DD3, and DD4.

(4) Loosen two setscrews E4 from odd band dial hub E1.

(5) Remove control bearing plate #1 assembly (AA) with assemblies C, D, E, F, G, and H intact. Assemblies A, B1, B2, J, and K will remain on control bearing plate #2 (BB).

Caution: Do not use undue force because damage to the gear teeth may result.

(6) The parts contained on control bearing plate #1 assembly (AA) may be removed by following the instructions given in subparagraph *c* below.

(7) Remove the six plate #2 stops L4 and the plate #1 stop L5 from stop collar L1.

(8) Loosen the three setscrews L3 on stop collar L1.

(9) Pry up on stop collar L1 and remove it from band switch tuning shaft U3.

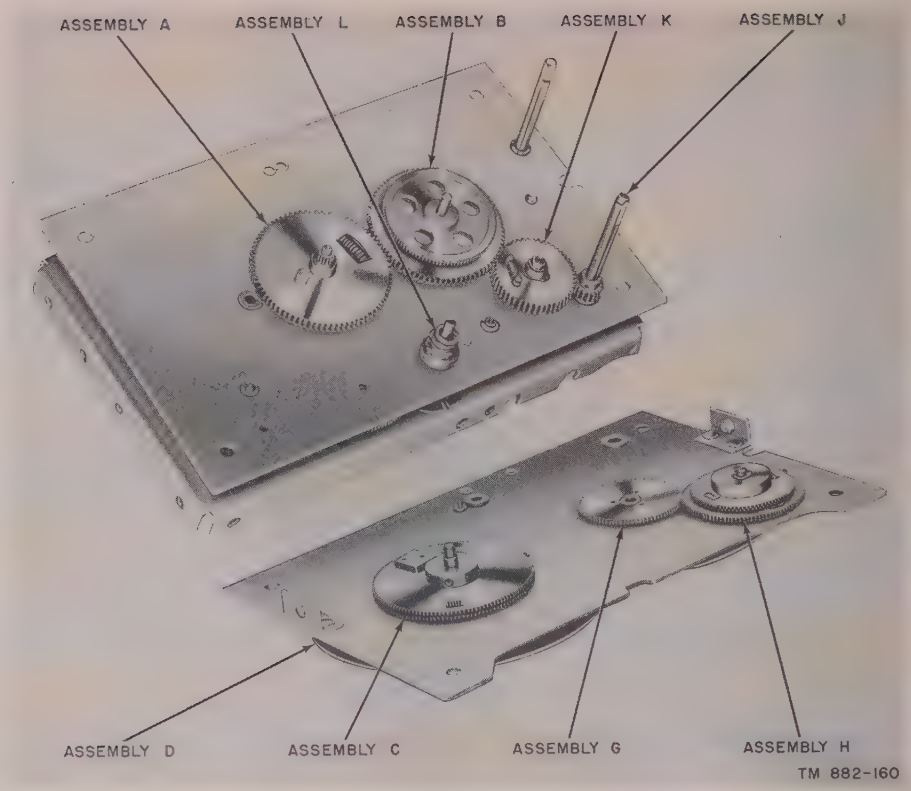

Figure 104. Control head, assemblies A through L.

(10) Remove control bearing plate #2 (BB) by lifting straight up.

(11) The parts contained on control bearing plate #2 assembly (BB) may be removed by following the instructions given in subparagraph *d*.

(12) The parts contained on control bearing frame #3 assembly (CC) may be removed by following the instructions given in subparagraph *e*.

c. Control Bearing Plate #1 Assembly (AA). The following parts are located on control bearing plate #1 assembly (AA): main dial gear assembly (C); main dial and hub assembly (D); odd band hub and dial assembly (E); even band dial assembly (F); r-f even band dial driven gear (G); and even band dial intermediate gear assembly (H). Instructions are given in subparagraphs (1) through (8) for removing these assemblies from the control bearing plate. If further disassembly is required, refer to figure 130. Assemblies C through H are removed as follows:

(1) *Assembly C.* Loosen two setscrews C3 from gear hub C2. Slide assembly C off main dial shaft D4.

(2) *Assembly D.* Remove assembly D by lifting away from control bearing plate #1 (AA).

(3) *Assembly E.* Loosen two setscrews E4 on odd band dial hub E1. Remove odd band dial E2 and odd band dial hub E1 by pulling forward off vernier drive shaft B5.

(4) *Assembly F.* Remove three machine screws F3 and lift assembly F off vernier drive shaft B5.

(5) *Assembly G.* With machine screws F3 removed, lift assembly G off vernier drive shaft B5.

(6) *Assembly H.* Remove Tru-arc retainer ring H6 from intermediate gear stud H5. Lift H1, H2, H3, H4, H7, H8, and H9 off intermediate gear stud H5.

d. Control Bearing Plate #2 Assembly (BB). The following parts are contained on control bearing plate #2 assembly (BB): oscillator gear and pinion assembly (A); even band dial gear assembly (B); tuning shaft and gear assembly (J); tuning shaft intermediate gear assembly (K); stop collar assembly (L); antenna trimmer intermediate gear #1 assembly (M); and antenna trimmer intermediate gear #2 assembly (N). Removal instructions for assemblies A, B, and J through N are outlined below. If further disassembly is required, refer to figures 130 and 131.

(1) *Assembly A.* Make certain the teeth on fixed oscillator anti-backlash gear A2 are in line with the teeth on free oscillator anti-backlash gear A5, then lift assembly A straight up disengaging it from r-f to oscillator gear B1.

(2) *Assembly B.* Loosen the three setscrews, B4, on the collar of the r-f even band dial driver gear B2 with a #4 Bristo wrench. Lift r-f to oscillator gear B1 and r-f even band dial driver gear B2 off vernier drive shaft B5 disengaging assembly B from assembly K.

(3) *Assembly J.* To remove tuning shaft and gear assembly J lift it out of control bearing plate #2 BB1.

(4) *Assembly K.* Remove Tru-arc retainer ring K7 from intermediate gear stud K9 and lift intermediate gears K1, K3, and K4 and associated parts K2, K5, K6, and K8 off intermediate gear stud K9.

(5) *Assembly L.* Most of the parts of assembly L have been removed in the partial disassembly procedure of subparagraph *b* above. To remove stop stud L6 remove hex nut L7 and lockwasher L8.

(6) *Assembly M.* Remove Tru-arc retainer ring M1 from antenna trimmer intermediate gear #1 stud M3 and pull antenna trimmer intermediate gear #1 M2 off antenna trimmer intermediate gear #1 stud M3.

(7) *Assembly N.* Remove Tru-arc retainer ring N1 from antenna trimmer intermediate gear #2 stud N3 and pull antenna trimmer intermediate gear #2 N2 off antenna trimmer intermediate gear #2 stud N3.

e. Control Bearing Frame #3 Assembly (CC). The following parts are contained on control bearing frame #3 assembly (CC): antenna trimmer gear and drive shaft assembly (O); antenna trimmer gear and shaft pinion (P); i-f and oscillator switch gear assembly (R); oscillator bevel gear and shaft assembly (S); turret miter gear and shaft assembly (T); miter gear terminal bracket assembly (U); miter gear turret bracket assembly (V); oscillator bevel gear bracket assembly (W); and i-f switch spur gear assembly (X). Removal instructions for assemblies O through X are outlined below. If further disassembly is required refer to figure 131.

(1) *Assembly O.* Assembly O consists of antenna trimmer drive gear O1 pinned to antenna trimmer drive shaft O2; to remove the assembly lift it off control bearing frame #3 (CC1).

(2) *Assembly P.* Assembly P consists of antenna trimmer pinion gear P1 pinned to antenna trimmer pinion shaft P2; to remove the assembly, lift it off control bearing frame #3 (CC1).

(3) *Assembly R.* Loosen two setscrews R3 and remove i-f spur gear R1 from oscillator switch drive shaft W2. To remove bevel gear R2 remove rollpin S11 from bevel pinion gear S2, then take bevel pinion gear S2 off bevel gear shaft S3; bevel gear R2 may now be removed.

(4) *Assembly S.* Bevel pinion gear S2 has been removed in the procedure given in subparagraph (3) above. To remove miter gear S1, remove rollpins S8, S9, and S10; pull bevel gear shaft S3 out through oscillator bevel gear bracket W1.

(5) *Assembly T.* Before removing parts of assembly T, miter gear V3 must be removed. Remove rollpin V5 which holds miter gear V3 to turret worm shaft V2. Remove turret worm shaft

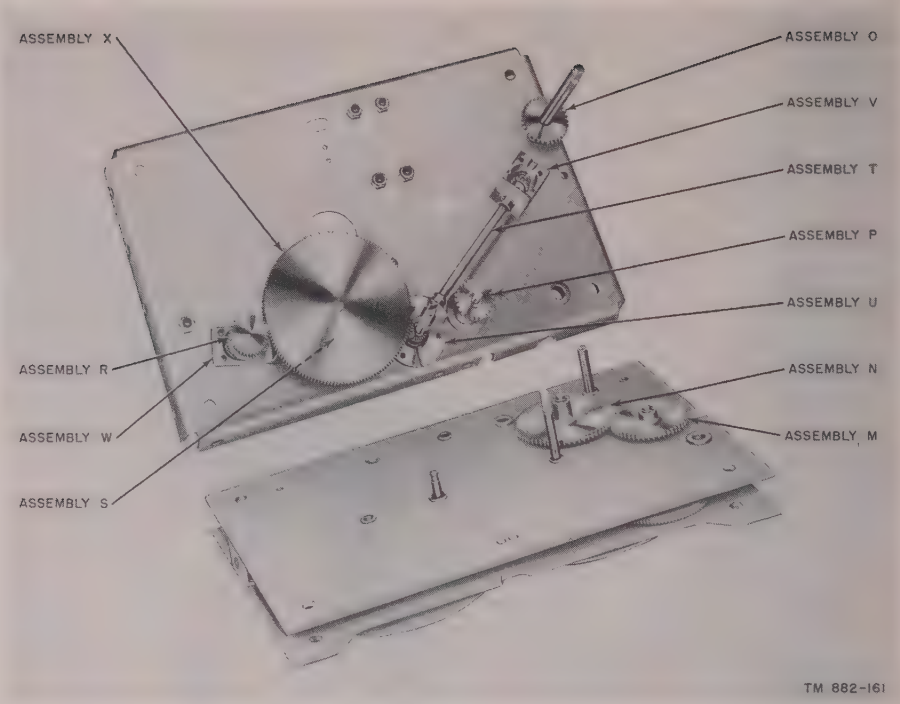

Figure 105. Control head, assemblies M through X.

V2. Remove rollpins T9, T10, and T11 and pull miter gear turret shaft T3 out through miter gear turret bracket V1. Miter gear T2 can be removed by removing rollpin T8 which holds miter gear T2 to miter gear turret shaft T3.

(6) *Assembly U.* With assemblies S and T removed, band switch tuning shaft U3 and miter gear U2 can be lifted out of miter gear terminal bracket U1. To remove miter gear terminal bracket U1, remove three screws U4 and lift it off control bearing frame #3 (CC1).

(7) *Assembly V.* With assembly T removed, miter gear turret bracket V1 can be removed by removing three screws V4, and lifting it off control bearing frame #3 (CC1).

(8) *Assembly W.* To remove oscillator switch shaft coupler W3 from oscillator switch drive shaft W2, remove rollpin W4. Remove oscillator bevel gear bracket W1 by removing three screws W5.

(9) *Assembly X.* Loosen setscrews X2 and lift i-f switch spur gear X1 from i-f switch gear shaft X4. Remove i-f switch gear shaft X4 and i-f switch coupler arm X7 by removing rollpin X8. Remove i-f switch gear shaft bearing X3 by removing hex nut X6 and washer X5.

f. Assembly of Control Head. When replacing the individual assemblies on the control bearing plates, reverse the steps taken in removal. To reassemble the control bearing plates proceed as follows:

(1) Place control bearing frame #3 assembly CC face up on a bench. Put a block of wood under each corner to protect the parts which protrude at the rear of the frame. Figure 105 shows the assemblies located on control bearing frame #3 assembly CC.

(2) Make certain that antenna trimmer intermediate gear #1 assembly M is meshed with antenna trimmer intermediate gear #2 assembly N on con-

trol bearing plate #2 assembly BB. Slide assembly BB over assembly CC. Engage antenna trimmer drive gear O 1 with antenna trimmer intermediate gear #1 assembly M and antenna pinion gear P1 with antenna trimmer intermediate gear #2 assembly N. To insure the proper spacing between control bearing plate #2 assembly BB and control bearing frame #3 assembly CC, insert spacer posts DD4 at each of the four corners.

(3) Slide stop collar L1 on band switch tuning shaft U3 until L1 is flush with control bearing plate #2 assembly BB. Tighten three setscrews L3. Slide stops L4 and L5 over shaft U3. Spring-load assembly K by rotating intermediate gear #1 K1 counterclockwise three teeth positions. Maintain the proper tension by engaging tuning shaft gear J1 with assembly K. Slide r-f to oscillator gear B1 and r-f even band dial driver gear B2 on vernier drive shaft B5 and tighten setscrews B4. Spring-load assembly A by holding free oscillator anti-backlash gear A 5 and rotating fixed oscillator anti-backlash gear A 2 counterclockwise three teeth positions. Position assembly A so that main stop stud A 4 will come in contact with main dial stop C5 when control bearing plate #1 is assembled. Maintain the proper tension on assembly A by engaging it with r-f to oscillator gear B1. Figure 104 shows control bearing plate #2 BB assembled to control bearing frame #3 CC.

(4) Spring-load gears H2 and H8 by rotating loose gear H2 counterclockwise one or two teeth positions. Maintain the proper tension by engaging the gears with assembly G. Spring-load gears H1 and H4 by rotating loose gear H1 counterclockwise one or two teeth positions. Use a paper clip or similar device to maintain the proper tension on these gears. Spring-load gears C1 and C4 by rotating loose gear C4 counterclockwise one or two teeth positions. Use a paper clip or similar device to maintain the proper tension. Figure 104 shows the assemblies contained on control bearing plate #1 assembly AA.

(5) Place control bearing plate #1 assembly AA over control bearing plate #2 assembly BB. Place spacer posts DD3 at each corner to maintain proper spacing between the plates. Engage spring-loaded gears H1 and H4 with r-f even band dial driver gear B1 and spring-loaded gears C1 and C4 with assembly A. After making certain all gears are properly engaged, remove the locking device on the spring-loaded gears. Slide bearing plate alinement bars DD1 through spacer posts DD2 and bearing plates AA, BB, and CC, and fasten them at the rear of control bearing frame #3 assembly CC with hex nuts DD6 and lockwashers DD5. Figure 103 shows an over-all view of the control head assembled.

g. Cross-reference Chart.

Assembly	Name	Manufacturers Part No.	Ref. symbol
A	Oscillator gear and pinion assembly		
A 1	Esna rollpin		
A 2	Fixed oscillator anti-backlash gear	244B1014	
A 3	Hub for oscillator gears	243B1085	
A 4	Main dial stop stud	246B1134	
A 5	Free oscillator anti-backlash gear	244B1006	P/O O 171
A 6	Oscillator to main dial pinion	244B1016	P/O O 171
A 7	Anti-backlash spring	241B1033	H193
AA	Control bearing plate #1 assembly		
AA1	Control bearing plate #1	264C1236	

g. Cross-reference Chart (contd).

Assembly	Name	Manufacturers Part No.	Ref. symbol
AA2	Even dial bearing	243B1092	
AA3	Oilite bearing F-303-1	243B1148	
AA4	Oilite bearing F-220-2	243K1149	
AA5	Oilite bearing F-310	243K1150	
AA6	Front cover tie angle	207A1404	
AA7	Esna clinchnut (4)	202K1097	
AA8	Control bearing plate #1 angle (2)	207A1402	
AA9	Rivet (6)	5S118988	
B	Even band dial gear assembly		
B1	R-f to oscillator gear	244B1008	P/O O 169
B2	R-f even band dial driver gear	244B1005	P/O O 169
B3	Esna rollpin		
B4	Bristo setscrews (3)		
B5	Vernier drive shaft	247B1149	O 211
BB	Control bearing plate #2 assembly		
BB1	Control bearing plate #2	264C1242	
BB2	Oilite bearing (2)	243B1134	
BB3	Oilite bearing	243B1137	
BB4	Oilite bearing	243B1136	
BB5	Oilite bearing	243B1135	
BB6	Oilite bearing F-303-1	243B1148	
C	Main dial gear assembly		
C1	Gear, tight	244B1068	P/O O 170
C2	Gear hub	243B1127	P/O O 170
C3	Bristo setscrews (2)		
C4	Gear, loose	244B1069	
C5	Main dial stop	246B1133	H220
C6	Spring (2)	241B1047	
CC	Control bearing frame #3 assembly	207C1410	O 187
CC1	Control bearing frame #3	207C1408	
CC2	Oilite bearing F-303-1	243B1148	
CC3	Oilite bearing F-310	243K1150	
CC4	Control frame #3 bearing	243B1138	
CC5	Clinchnut (16) #68 NC-2-40	202K1076	
CC6	Clinchnut (6) #68 NC-2-62	202K1096	
D	Main dial and hub assembly	234C1015	
D1	Main dial hub	243A1110	O 214
D2	5″ dial	234A1006	H215
D3	Machine screws (3)	3S400818	
D4	Main dial shaft	247A1131	
DD	Spacer post assembly		
DD1	Bearing plate alinement bar (4)	247A1163	H209 to H212
DD2	Bearing plate #1 spacer posts (4)	243A1056	H197 to H200
DD3	Bearing plate #2 spacer posts (4)	243A1111	H205 to H208
DD4	Bearing plate #3 spacer posts (4)	243K1178	H201 to H204
DD5	Lockwashers (4)		
DD6	Hex nuts (4)		
E	Odd band hub and dial assembly	234C1014	
E1	Odd band dial hub	243A1058	O 213
E2	Odd band dial	234A1010	H214

Assembly	Name	Manufacturers Part No.	Ref. symbol
E3	Machine screws (3)	3S400818	
E4	Bristo setscrews (2)		
F	Even band dial assembly		
F1	Even band dial	234K1007	H213
F2	Even band dial gear hub	243B1087	O 167
F3	Machine screws (3)		
G	R-f even band dial driven gear	244B1010	O 168
H	Even band dial intermediate gear assembly		
H1	Gear, loose	244B1067	
H2	Gear, loose	244B1065	
H3	Even band dial intermediate gear hub	243B1229	
H4	Gear, tight	244B1006	
H5	Intermediate gear stud	246A1012	
H6	Tru-arc retainer ring		
H7	Spring (2)	241B1046	
H8	Gear, tight	244B1064	
H9	Spring (2)	241B1046	
J	Tuning shaft and gear assembly	247B1100	O 172
J1	Tuning shaft gear	244B1036	P/O O 172
J2	Tuning shaft	247B1124	P/O O 172
J3	Esna rollpin		
K	Tuning shaft intermediate gear assembly		
K1	Intermediate gear #1	244B1035	
K2	Intermediate gear #1 stud	246B1114	
K3	Intermediate gear #2	244B1034	O 174
K4	Intermediate gear #3	244B1042	
K5	Intermediate gear #3 stud	246B1119	
K6	Intermediate gear spring	241B1105	P/O O 173
K7	Tru-arc retainer ring		
K8	Tru-arc retainer ring		
K9	Intermediate gear stud	246B1117	
K10	Washer	204B1119	
L	Stop collar assembly		
L1	Stop collar	243B1251	
L2	Rollpin		
L3	Bristo setscrews (3)		
L4	Plate #2 stops (6)	264A1221	O 307 to O 310, O 317, and O 318
L5	Plate #1 stop	264A1231	O 306
L6	Stop stud	246B1152	
L7	Hex nut	2S115298	
L8	Lockwasher	4S114621	
M	Antenna trimmer intermediate gear #1 assembly		
M1	Tru-arc retainer ring		
M2	Antenna trimmer intermediate gear #1	244B1043	O 180
M3	Antenna trimmer intermediate gear #1 stud	246B1083	
N	Antenna trimmer intermediate gear #2 assembly		
N1	Tru-arc retainer ring		
N2	Antenna trimmer intermediate gear #2	244B1048	O 181
N3	Antenna trimmer intermediate gear #2 stud	246B1085	
O	Antenna trimmer gear and drive shaft assembly	247B1153	O 179
O 1	Antenna trimmer drive gear	244B1047	

g. Cross-reference Chart (contd).

Assembly	Name	Manufacturers Part No.	Ref. symbol
O 2	Antenna trimmer drive shaft	244B1145	
O 3	Esna rollpin		
P	Antenna trimmer gear and shaft pinion	244B1050	O 178
P1	Antenna trimmer pinion gear	244B1045	
P2	Antenna trimmer pinion shaft	247B1143	
P3	Esna rollpin		
R	I-f and oscillator switch gear assembly	244C1060	P/O O 200
R1	I-f spur gear	244C1051	
R2	Bevel gear	244B1003	
R3	Bristo setscrews (2)		
S	Oscillator bevel gear and shaft assembly	247B1091	P/O O 200
S1	Miter gear	244B1001	
S2	Bevel pinion gear	244K1053	O 191
S3	Bevel gear shaft	247B1110	
S4	Thrust collar	243B1225	
S5	Thrust bearing	243B1224	
S6	Thrust collar	243B1225	
S7	Thrust bearing	243B1224	
S8 to S11	Esna rollpin (4)		
T	Turret miter gear and shaft assembly	247B1092	O 190
T1	Miter gear	244B1001	O 192
T2	Miter gear	244B1001	O 193
T3	Miter gear turret shaft	247B1106	
T4	Thrust collar	243B1225	
T5	Thrust bearing	243B1224	
T6	Thrust collar	243B1225	
T7	Thrust bearing	243B1224	
T8 to T11	Esna rollpin (4)		
U	Miter gear terminal bracket assembly		
U1	Miter gear terminal bracket	207C1346	A 123
U2	Miter gear	244B1001	
U3	Band switch tuning shaft	247B1213	
U4	Screws (3)		
U5	Esna rollpin		
V	Miter gear turret bracket assembly		
V1	Miter gear turret bracket	207C1348	A 121
V2	Turret worm shaft (short)	247B1079	O 194
V3	Miter gear	244B1001	
V4	Screws (3)		
V5	Esna rollpin		
W	Oscillator bevel gear bracket assembly		
W1	Oscillator bevel gear bracket	207C1347	A 143
W2	Oscillator switch drive shaft	247A1061	
W3	Oscillator switch shaft coupler	243A1080	
W4	Esna rollpin		
W5	Screws (3)		
X	I-f switch spur gear assembly		
X1	I-f switch spur gear	244B1002	O 198
X2	Bristo setscrews (2)		
X3	I-f switch gear shaft bearing	243B1081	O 197
X4	I-f switch gear shaft	247B1065	P/O O 196
X5	Washer	204B1043	H196

Assembly	Name	Manufacturers Part No.	Ref. symbol
X6	Hex nut	202B1064	
X7	I-f switch coupler arm	245B1009	P/O O 196
X8	Esna rollpin		

101. Disassembly of First Mixer Section

a. General. The first mixer section is a compact subchassis containing six amplifier subassemblies and a crystal calibrator subassembly. Replacement of parts on the crystal calibrator subassembly is not difficult; however, because of compactness, it may be necessary to remove the amplifier subassemblies to make repairs. In order to remove a subassembly, the turret must be removed first.

b. Removal of Turrets (figs. 106 and 107). Each turret is fastened to its respective shaft by means of two Bristo setscrews. To remove any one of the seven turrets proceed as follows:

(1) Loosen the two setscrews with a Bristo wrench. Do not remove the setscrews from the holes. The turret will now be free to rotate on the shaft.

(2) Rotate the turret so that the contacts on the turret card do not touch the wiper contacts on the frame.

(3) Remove the turret by pulling it forward off the shaft.

(4) The turret cards may be removed from the turret by prying the end plates apart and lifting the card out (fig. 107).

(5) The turrets may be replaced by reversing the disassembly procedure. When putting the turret back on the shaft make certain the setscrew holes line up with the flatted portions of the shaft.

c. Removal of Subassemblies (figs. 108, 109, 110, and 111). In order to remove the subassemblies from the subchassis, the turrets must be removed. To do this, perform the procedure given in subparagraph *b* above. To remove the subassemblies proceed as follows:

(1) Remove the side plates by removing the screws around the outside of the plates.

(2) Unsolder all the connections on the subassembly which go to other parts of the subchassis. Tag each connection as it is removed so that proper rewiring will be made.

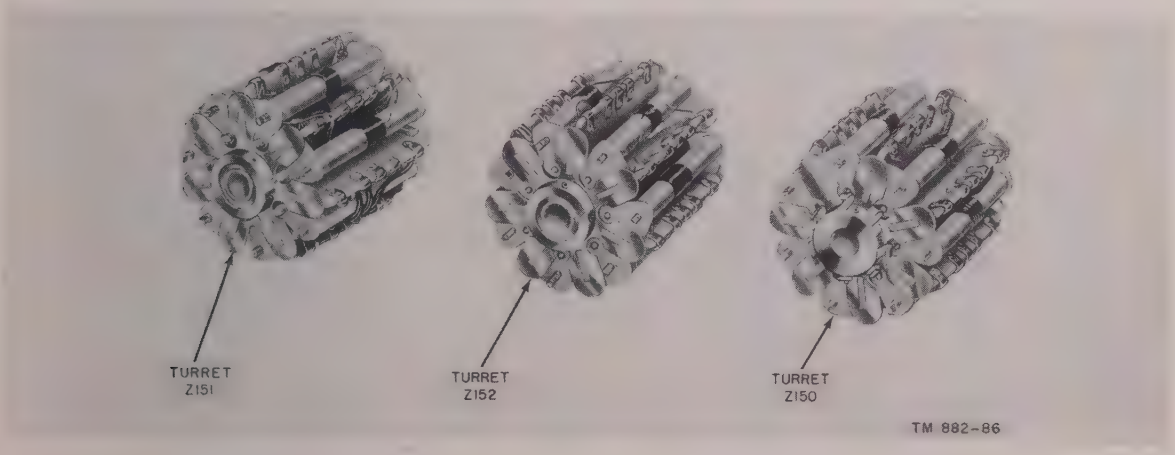

Figure 106. Radio Receiver R-220/URR, turrets Z150, Z151, and Z152.

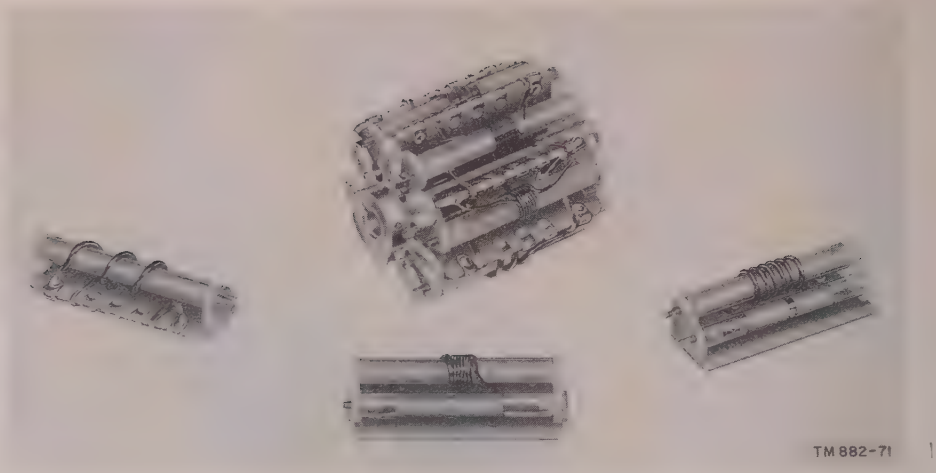

Figure 107. Radio Receiver R–220/URR, r-f turret assembly.

(3) Remove the three screws which fasten the subassembly to the frame.

(4) Subassemblies Z166, Z168, and Z170 may now be removed from the frame.

(5) To remove subassembly Z175 loosen the two setscrews on the flexible shaft coupler. Pull the flexible shaft back so that the collar slides off the rigid shaft. Remove the flexible shaft by pulling it forward through the hole in the subassembly plate.

(6) To remove subassemblies A 112 or Z172 loosen the two setscrews on the shaft collar. Remove the worm gear and pull the rigid shaft out through the holes in the subassembly plates.

(7) Subassemblies A 112 or Z172 may now be removed from the frame.

(8) When the subassemblies are removed from the subchassis do not change the setting of the variable capacitors or realinement will be necessary.

(9) Replace the subassemblies by reversing the above procedure.

102. Disassembly of Main Unit

a. General. Before repairing or replacing any parts in the main unit, other than tubes, the power supply and r-f unit must be removed. Refer to paragraph 17.

b. Removal of Front Panel.

(1) Remove all front panel control knobs.

(2) Unsolder the two wires attached to meter M301. When resoldering the wires, make certain that the red wire

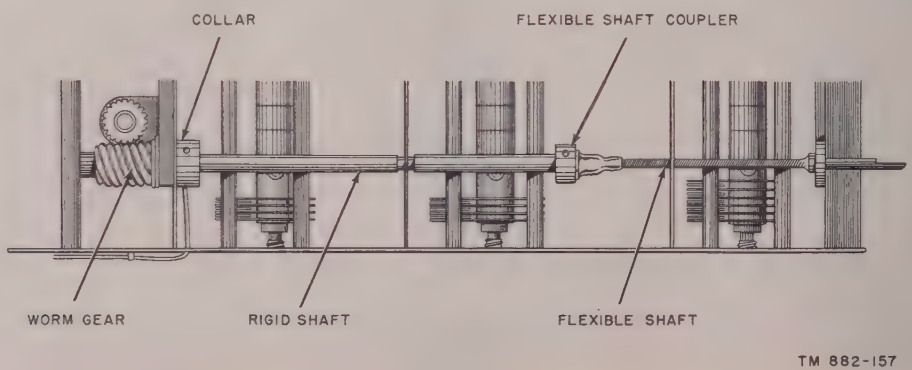

Figure 108. Antenna trimmer shaft removal.

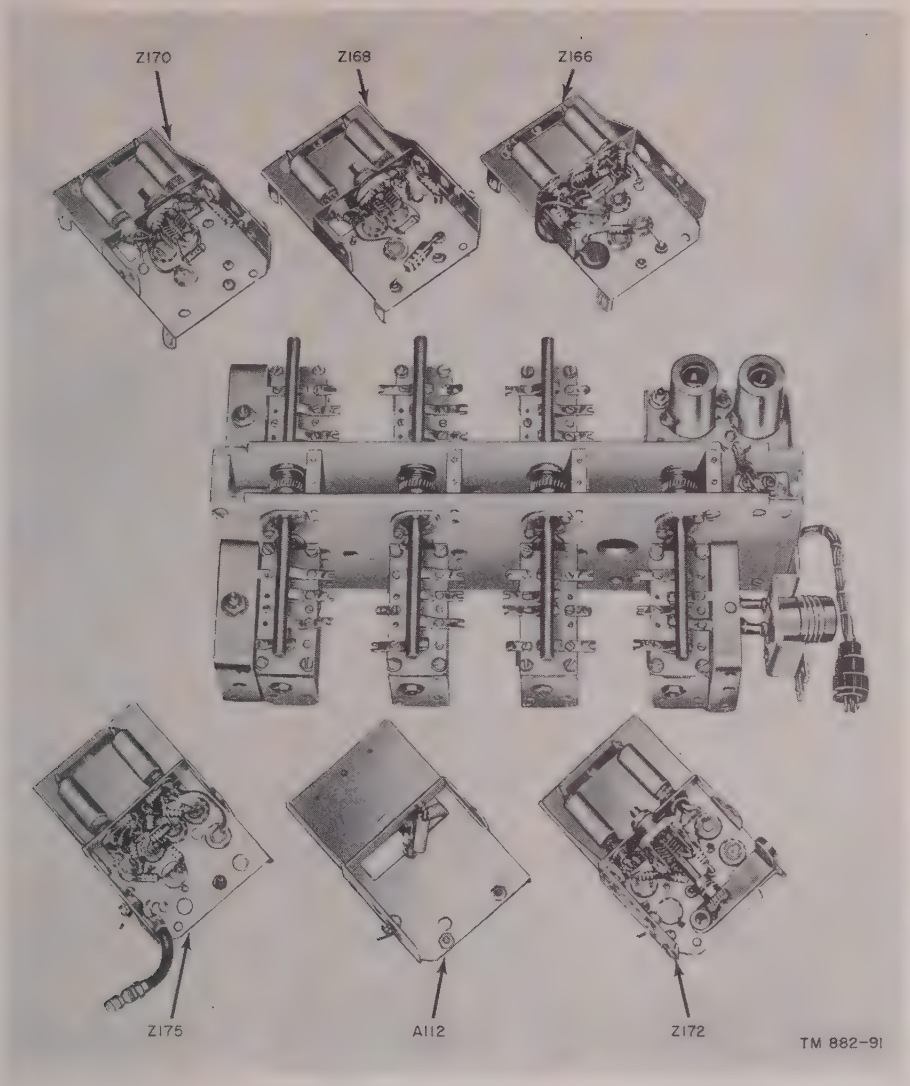

Figure 109. R-f turret partition disassembled.

is soldered to the terminal marked "+".

(3) Unsolder the wires attached to the AUDIO OUTPUT jacks. Tag each wire or make a pencil sketch of the wiring so that the proper connections will be made when the panel is replaced.

(4) Place blocks of wood at each corner of the chassis so that the front panel does not touch the bench.

(5) Remove the six Phillips head screws which hold the front panel to the chassis.

(6) Remove the four Allen head cap screws which hold the two handles to the chassis.

(7) The front panel may now be removed from the chassis.

(8) Replace the front panel by reversing the above procedure.

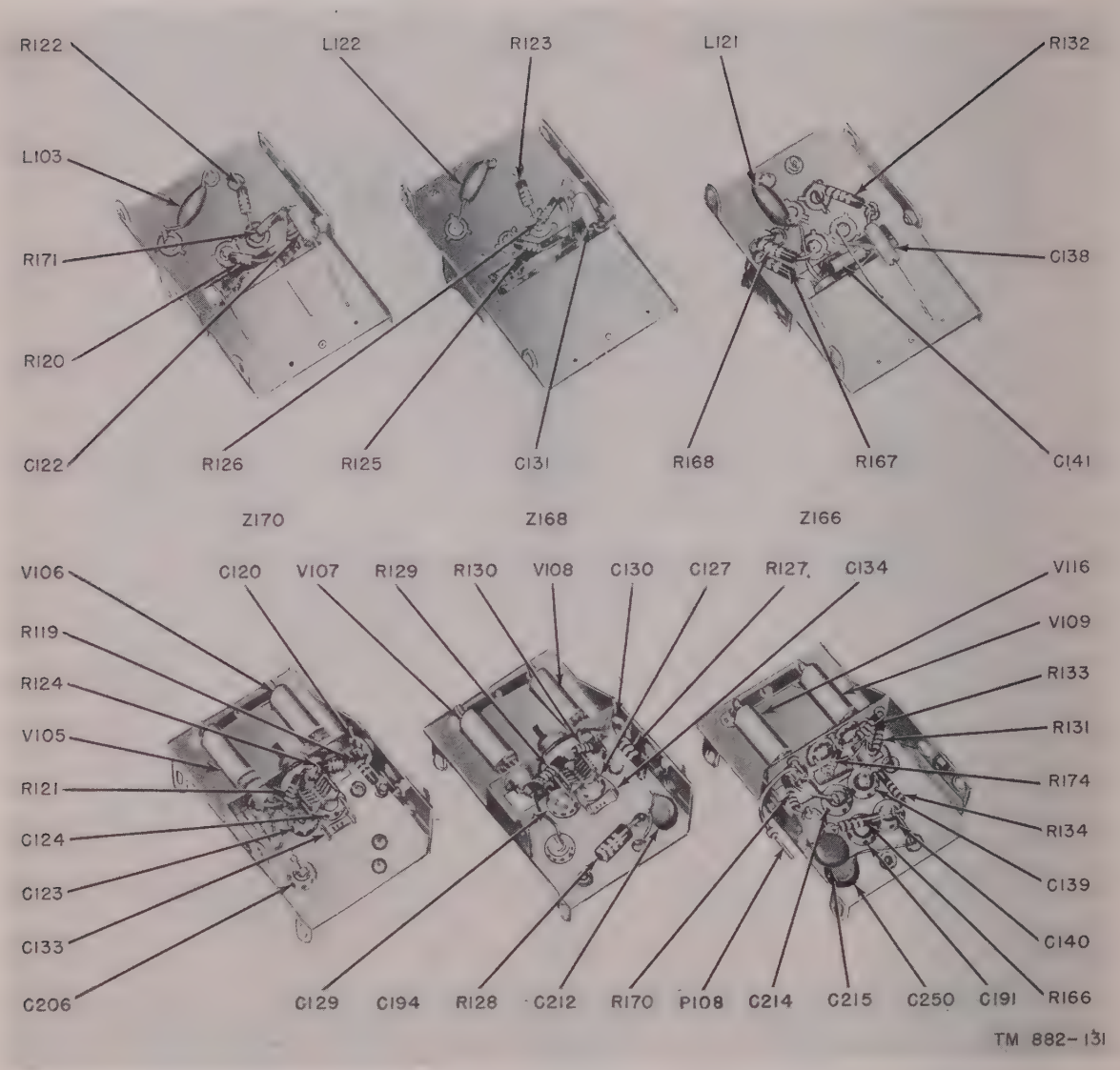

Figure 110. R-f turret partitions, section B.

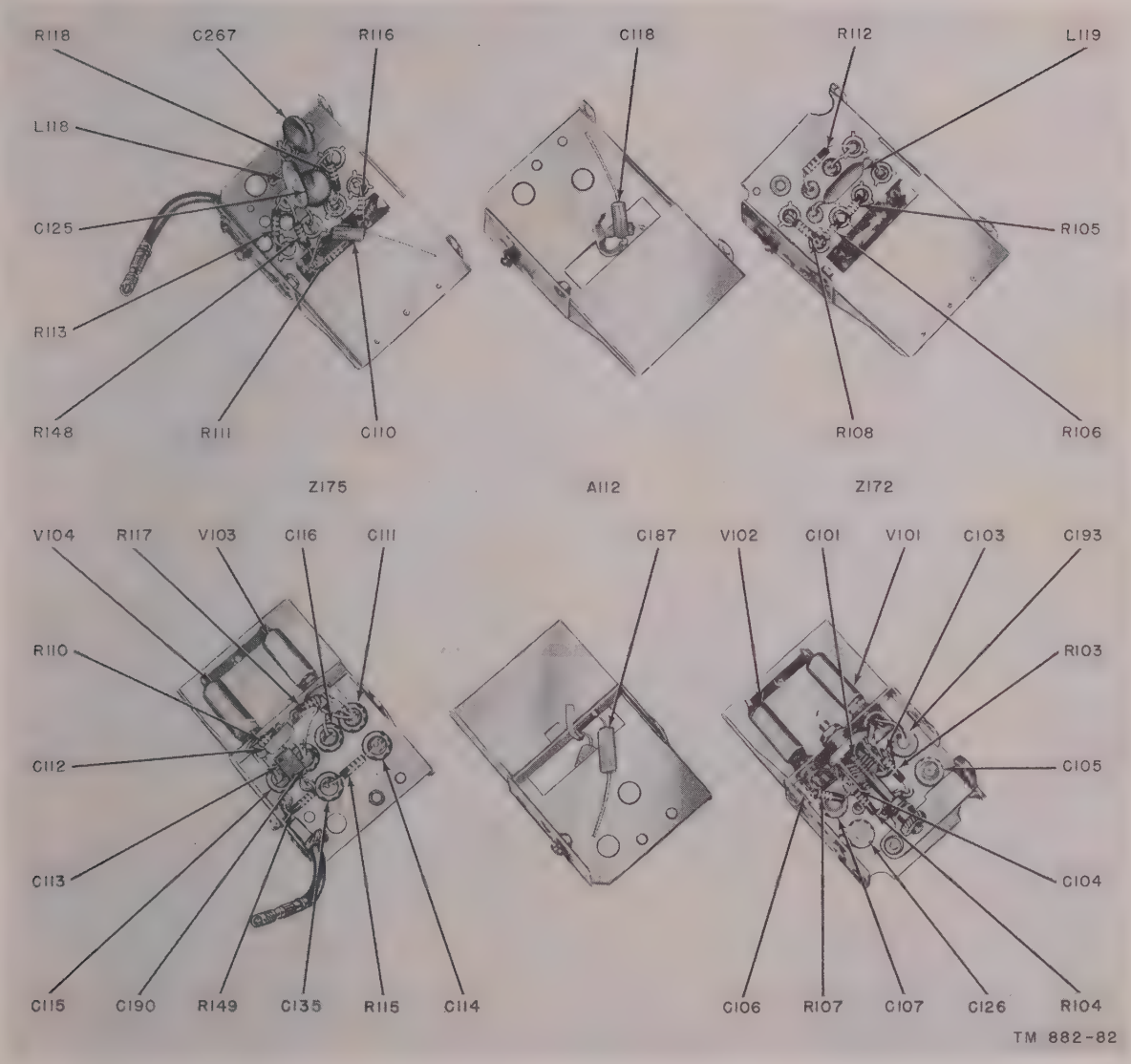

Figure 111. R-f turret partitions, section D.

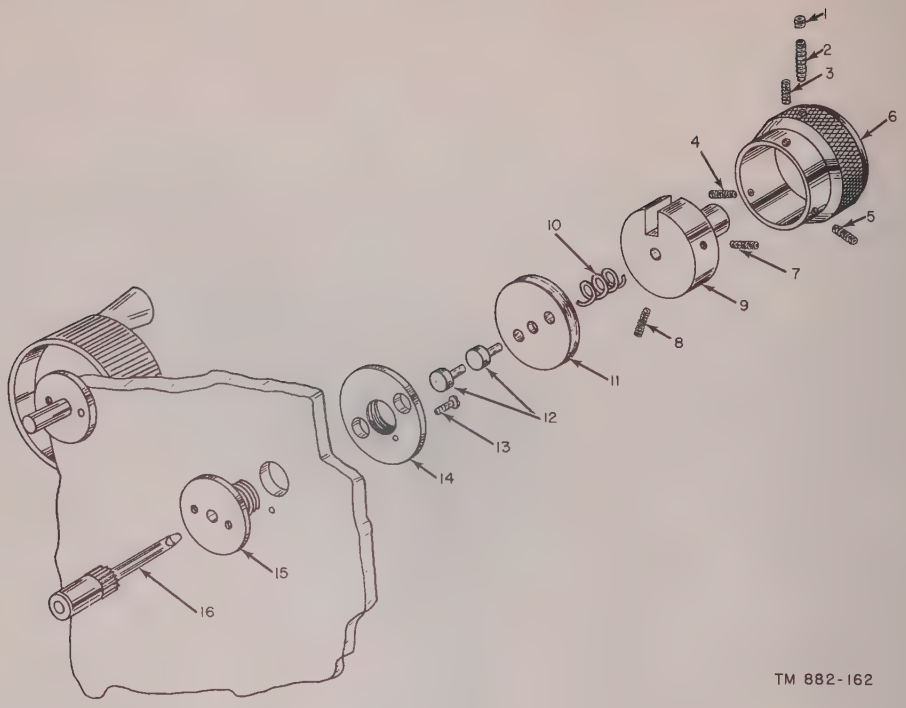

Figure 112. BAND SELECTOR knob, exploded view.

c. Disassembly of BAND SELECTOR Knob. Figure 112 shows an exploded view of the BAND SELECTOR control knob. Reference numbers are assigned to parts on the illustration as an aid in disassembly. A cross reference chart in subparagraph *d* lists the reference number, name, manufacturers part number, and reference symbol of parts shown in figure 112. To disassemble the control knob, proceed as follows:

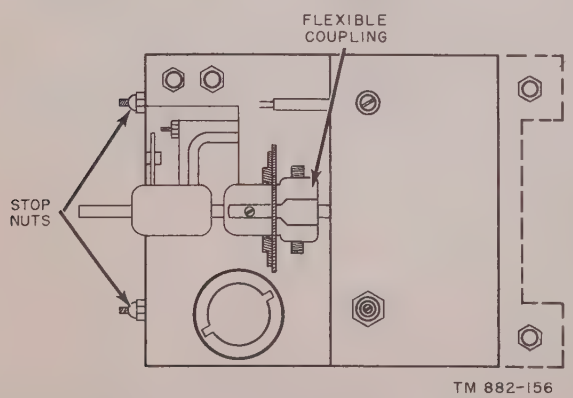

Figure 113. Bfo subchassis removal.

(1) Remove setscrew 1 from band switch knob 6.

(2) Loosen setscrew 2.

(3) Remove setscrews 3, 4, and 5 and slide band switch knob 6 off band switch shaft pinion 16.

(4) Loosen setscrews 7 and 8 and pull band switch knob activator 9 *slowly* off band switch shaft pinion 16. By doing this, the tension on band switch knob spring 10 is released gradually and it will not fly off the shaft.

(5) Remove band switch knob spring 10.

(6) Slide retaining plate assembly 11 off band switch shaft pinion 16.

(7) Remove locking plate assembly 14 by removing binder head screw 13 and unscrewing locking plate assembly 14 from seal holder 15.

(8) Reassemble by reversing the above procedure.

d. Cross-reference Chart.

Ref. Number	Name	Manufacturers part no.	Reference symbol
1	Setscrew (10-32 x 1/8 Allen head)	3S118473	
2	Setscrew (10-32 x 1/2 Allen head)	3S120485	
3	Setscrew (10-32 x 3/16 Bristo head)	3S123245	
4	Setscrew (10-32 x 3/16 Bristo head)	3S123245	
5	Setscrew (10-32 x 3/16 Bristo head)	3S123245	
6	Band switch knob	236B1017	H355
7	Setscrew (10-32 x 1/2 Allen head)	3S120485	
8	Setscrew (10-32 x 1/2 Allen head)	3S120485	
9	Band switch knob activator plate	264B1409	O 319
10	Band switch knob spring	241B1044	H390
11	Retainer plate	264B1404	P/O H392
12	Band switch knob stop stud	246B1154	P/O H392
13	Binder head screw (3–48 x 1/8)	3S116266	
14	Locking plate assembly	264B1407	H391
15	Seal holder	243B1117	H354
16	Band switch sleeve and pinion assembly	244B1023	

e. Removal of Bfo Subchassis.

(1) Remove the tube shield and tube from the bfo subchassis.

(2) Unsolder the five wires which are attached to the subchassis. Tag each wire as it is removed.

(3) Loosen the two slotted head setscrews on the flexible coupling that is nearest the oscillator shield.

(4) Pull the B.F. OSCILLATOR control knob away from the front panel so that the flexible coupling is clear of the shaft.

(5) Remove the two stop nuts which hold the subchassis to the front of the main chassis.

(6) Remove the two screws which hold the rear of the subchassis to the main chassis.

(7) Remove the subchassis by pulling it up and tilting it so that the rear flange clears the wiring on the main chassis.

103. Cable Connections

The following chart lists all the internal cables, their length, terminations, and mating connections in Radio Receiver R–220/URR. This chart will aid in reconnecting the various sections of the receiver.

Cable	Length (in.)	Plug	Mating Connection	Jack	Mating Connection
1st mixer section coaxial cable	4	P101	J101	See note	
1st mixer section power cable	7	P103	J103	See note	
1st hfo section heater power cable	3	P104	J104	See note	
1st hfo section output cable	3 1/2	P108	J108	See note	
2d mixer section power cable	2 1/2	P102	J102	See note	
Main unit coaxial cable	4 3/4	P308	J308	See note	
Cable assembly W301	7	P306	J106	P307	J307
Cable assembly W302	22	P105	J105	P304	J304
Cable assembly W304	18	P303	J303	P604	J304

Note. These cables consist of one or more wires having a plug on one end only; the other end in each case is permanently fastened to the receiver.

104. Special Repair Procedures

a. General. Most of the parts in the main unit of the receiver are readily accessible and can be replaced easily without special instructions. Special repair procedures are required for repairing or replacing the dial masks, filters, transformers, tube sockets, and connectors.

b. Dial Masks. In order to remove the kilocycle dial mask and the megacycle dial mask, the r-f unit must be removed from the receiver. Instructions for removal of the r-f unit are given in paragraph 17. To remove the dial masks proceed as follows:

(1) Rotate the BAND SELECTOR control to band 7.

(2) Remove the Phillips head screw that holds the kilocycle dial mask assembly to the front panel.

(3) Pull the dial mask assembly away from the rear of the panel. Do not use force because damage to the gears may result.

(4) The mask may now be removed from the assembly by removing the three binder-head screws.

(5) When replacing the mask make certain that the holes in the hub line up with the holes in the gear.

(6) The megacycle dial mask assembly is removed in the same manner as the kilocycle dial mask assembly.

c. Filters. The 1.75-mc filter, FL301, and the selectivity filters, FL302, FL303, and FL304, are similar in mechanical construction and the following instructions pertain to any one of the filters.

(1) Unsolder the wires attached to either end of the filter.

(2) Remove the four nuts and lockwashers that secure the filter to the chassis. It may be necessary to move terminal boards TB301 and TB302 slightly to get at the nuts. To do this loosen the two screws that hold the terminal board in place. Move the terminal board just enough to expose the nuts. Be careful not to damage any of the parts when moving the terminal board.

(3) The filter may now be removed from the chassis by lifting it straight up.

(4) To replace the filter reverse the procedure above.

d. Tube Sockets. All sockets are attached to the chassis by means of rivets or screws. To change a socket, proceed as follows:

(1) Remove the part plugged into the socket.

(2) Unsolder the wires connected to the socket.

(3) Drill out the two rivets or remove the screws that fasten the socket to the chassis.

(4) Substitute a new socket and fasten it with rivets or machine screws, lockwashers, and nuts.

(5) Resolder the wires to the socket.

(6) Clean the unit thoroughly to remove solder drops and metal chips.

(7) Check the new connections with those shown on the schematic for that unit.

e. Connectors.

(1) Tie together all wires and tag each wire individually with its terminal designation.

(2) Unsolder the wires.

(3) Remove the two screws holding the connector in place.

(4) Remove the connector and repair or replace it.

(5) Place the new connector in position and push the machine screws in from the outside.

(6) Fasten the connector tightly in place with the original nuts.

(7) Carefully resolder the wires.

105. Lubrication of Equipment at Field Maintenance Level

a. General Lubricating Instructions. Do not use excessive amounts of oil or grease and do not allow electrical connections to become greasy. Make certain that lubricants and points to be lubricated are free of sand, dirt, or grit;

abrasives are the chief cause of wear and often cause breakdown of gear assemblies. Before lubrication, clean all surfaces with a lint-free cloth dampened with solvent (SD).

b. Lubrication of Switches. Approximately once every 3 months, clean the exposed bearing surfaces of switch detents and switch mechanisms; sparingly apply Grease MIL–G–3278. Remove excess grease to prevent possible malfunctioning of other parts, especially switch contacts.

106. Refinishing

Instructions for refinishing badly marred panels on the exterior cabinets are given in TM 9–2851, Painting Instructions for Field Use.

Section III. RADIO RECEIVER R–220/URR ALINEMENT

107. General

a. Conditions for Alinement. Remove the receiver from its case. For best results, the equipment should be set up on a metal-top bench located in a grounded screen room. All equipment should be bonded to the bench. In many cases, however, a screen room and a metal-top bench are not available. If the receiver must be alined without them, make certain there is a good ground connection between the receiver and test equipment. Allow approximately ½ hour for all equipment to warm up before starting the alinement procedure. The input voltage to the receiver and test equipment must be maintained at 115-volts a-c during alinement procedures. A dummy antenna consisting of a resistive network designed to match the signal generator output impedance and the receiver input impedance should be used.

b. Receiver Controls. Unless otherwise specified, set the receiver front panel controls to the following positions:

(1) BAND SELECTOR to band 2.

(2) TUNING to 30 mc.

(3) B.F. OSCILLATOR to OFF.

(4) SELECTIVITY to 50 K.C.

(5) AUDIO RESPONSE to WIDE.

(6) R.F. GAIN–SQUELCH to approximate mid-position.

(7) AUDIO GAIN 1 and AUDIO GAIN 2 to approximate mid-positions.

(8) NOISE LIMITER to OFF.

(9) OPERATION to MGC.

(10) METER switch to CARRIER.

(11) CALIBRATE to OFF.

108. First High-frequency Oscillator Alinement

a. Receiver Tuning-dial Capacitor Zeroing. Remove the r-f unit from the main unit following the instructions outlined in paragraph 17*e*. Remove the first hfo dust cover (A 104) and replace the r-f unit.

(1) Unsolder the lead from the stator of C152 which goes to L107 and C151 (fig. 96). Connect a low scale ohmmeter between ground and the stator of C152. Place a small flat-edged metal strip across the bottom of the stator plates of C152. Rotate the receiver TUNING control until C152 is at zero mesh (maximum capacitance) position. This occurs when the rotor plates make contact with the flat-edged metal strip across the stator resulting in a zero reading on the ohmmeter. Loosen the setscrews in the coupling shaft so that C152 will remain zeroed when the receiver TUNING control is rotated. Resolder the lead from L107 to C152.

(2) Unsolder the lead from the stator of C155 which goes to L106 and C153 (fig. 96). Connect the low scale ohmmeter between ground and the stator of C155. Place a small flat-edged metal strip across the bottom of the stator plates of C155. Rotate the receiver TUNING control until C155 is at zero mesh position (indicated in the same manner as for C152). Loosen the setscrews in the coupling shaft so that C155 will remain zeroed when the receiver TUNING control is rotated. Remove the ohmmeter and the flat-edged metal strip. Resolder the lead from L106 to C155.

(3) Rotate the kilocycle dials until the guide dot markers are in line with the notched marker at the top of control bearing plate #1 (fig. 114). If the guide dots do not line up with the marker, loosen the dial setscrews and aline them; tighten the setscrews.

(4) Loosen the setscrews on the megacycle dial assembly and aline the solid line at the low-frequency end of the dial with the notched marker at the top of control bearing plate #1; tighten the setscrews (fig. 114).

(5) Tighten the setscrews on coupling shafts to both C152 and C155.

b. Odd-band Alinement. Before attempting to aline the first hfo make certain the filament voltage is 6.3 volts, B+ is 105 volts d-c, and the first hfo heater voltage is 115 volts a-c. Disconnect B+ from the multiplier and r-f stages.

(1) Remove the multiplier dust cover. Adjust the shafts of oscillator trimmers C154 and C158 until the slots are in a vertical position. Adjust L107, C108, C156, and C157 to approximately the middle of their ranges.

(2) Using a low range ohmmeter check the continuity through heater element HR101 (fig. 93). Replace the dust cover to the first hfo assembly making certain that P104 is connected to J104. Replace the r-f unit in the main chassis.

(3) Rotate the BAND SELECTOR to band 1 position. Loosely couple the lead from Frequency Meter BC–221 to the stand-off terminal which connects the lead from P108 to pin 1 of V116. Rotate the TUNING control to 20.08 mc. This setting results in a 6-degree rotation of C155 from zero mesh. Set the frequency meter to 13.9856 mc which is the actual oscillator frequency for a 6–degree rotation of C155. Adjust L108 until a zero beat is heard at the headset (indicating that the oscillator frequency is the same as that of the frequency meter).

(4) Set the receiver TUNING dial to 29.413 mc. This setting results in a 174-degree rotation of C155 from zero mesh. Set the frequency meter to 23.3189 mc (harmonic of 11.6594 mc on Frequency Meter BC–221) which is the actual oscillator frequency for a 174–degree rotation of C155. Adjust C156 until a zero beat is heard at the headset.

(5) Repeat the process outlined in subparagraphs (3) and (4) until no further adjustment of L108 and C156 is required to set the oscillator for the proper dial frequency. The chart below lists oscillator frequencies with corresponding dial readings and the allowable error in dial setting. The *degree* column lists the degree of rotation for C155. The *oscillator frequency* column lists the corresponding oscillator frequency while the *dial frequency* column indicates the proper dial setting at the front panel of the receiver. Using the information in the chart below measure the oscillator frequency with respect to the dial frequency for every ten degrees rotation of C155. If, at any setting, the actual error is in excess of the allowable error, realine the odd band circuit following the procedure outlined in subparagraphs (1) through (4).

Degree	Oscillator frequency (mc)	Dial frequency (mc)	Allowable error (kc)
0	13.6523	19.746	9.5
6	13.9856	20.080	10.0
10	14.2078	20.302	10.0
20	14.7634	20.858	10.0
30	15.31896	21.413	10.0
40	15.8745	21.969	10.5
50	16.43008	22.524	11.0
60	16.9856	23.080	11.0
70	17.54118	23.635	11.0
80	18.0967	24.191	12.0

Degree	Oscillator frequency (mc)	Dial frequency (mc)	Allowable error (kc)
90	18.6523	24.747	12.0
100	19.2078	25.302	12.0
110	19.7634	25.858	12.5
120	20.3189	26.413	13.0
130	20.8745	26.969	13.0
140	21.4301	27.524	13.0
150	21.9856	28.080	14.0
160	22.5412	28.635	14.0
170	23.0967	29.191	14.0
174	23.3189	29.413	14.0
180	23.6523	29.747	14.5

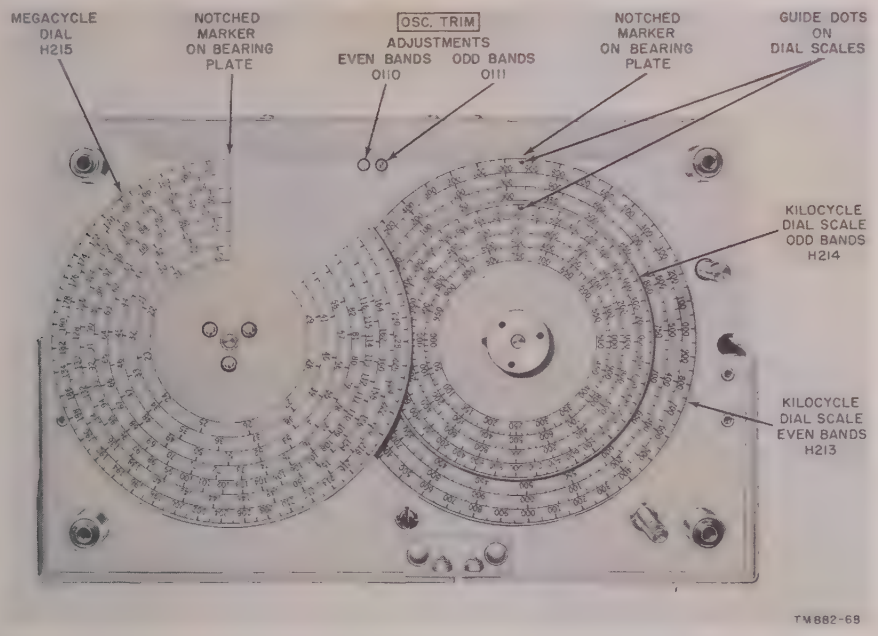
MEGACYCLE DIAL H215
NOTCHED MARKER ON BEARING PLATE
OSC. TRIM ADJUSTMENTS
EVEN BANDS 0110
ODD BANDS 0111
NOTCHED MARKER ON BEARING PLATE
GUIDE DOTS ON DIAL SCALES
KILOCYCLE DIAL SCALE ODD BANDS H214
KILOCYCLE DIAL SCALE EVEN BANDS H213
TM 682-68

Figure 114. R-f unit, front view, showing dial system and oscillator trimmer adjustments.

c. Even-band Alinement. Rotate the BAND SELECTOR to band 2 position.

(1) Set the receiver dial to 28.458 mc which is equal to a 6-degree rotation of C152. Adjust the frequency meter to 9.911 mc, which is the actual oscillator frequency at 6 degrees rotation of C152. Adjust L107 until a zero beat is heard at the headset.

(2) Set the receiver TUNING dial to 41.686 mc, which is equal to a 174–degree rotation of C152. Adjust the frequency meter to 16.524 mc which is the actual oscillator frequency at 174 degrees rotation of C152. Adjust C157 until a zero beat is heard at the headset.

(3) Repeat the process outlined in subparagraphs (1) and (2) until no further adjustment of L107 and C157 is required to set the oscillator for the proper dial frequency. The following chart lists oscillator frequencies with corresponding dial readings and the allowable error. If, at any setting, the actual error is in excess of the allowable error, realine the even band circuit following the procedure outlined in subparagraphs (1) and (2).

(4) Remove the r-f unit from the main chassis and replace the multiplier dust cover. Replace the r-f unit in the main chassis.

c. Even-band Alinement (contd).

Degree	Oscillator frequency (mc)	Dial frequency (mc)	Allowable error (kc)
0	9.674	27.985	13.5
6	9.911	28.458	14.0
10	10.068	28.773	14.0
20	10.462	29.561	14.0
30	10.856	30.348	15.0
40	11.249	31.135	15.0
50	11.643	31.923	15.5
60	12.0366	32.710	16.0
70	12.430	33.497	16.0
80	12.824	34.285	17.0
90	13.2176	35.072	17.0
100	13.6113	35.859	17.5
110	14.005	36.647	18.0
120	14.398	37.434	18.0
130	14.792	38.221	19.0
140	15.186	39.009	19.0
150	15.580	39.796	19.5
160	15.973	40.583	20.0
170	16.367	41.371	20.0
174	16.524	41.686	20.0
180	16.761	42.158	21.0

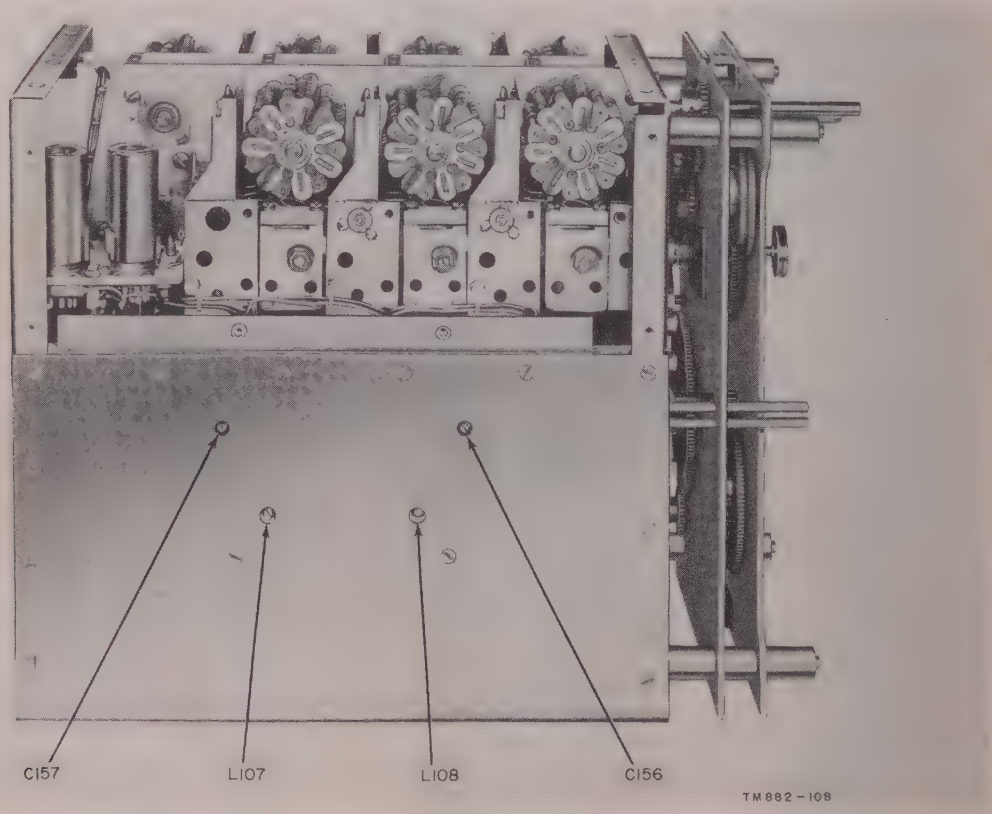

Figure 115. First hfo alinement points.

109. Second High-frequency Oscillator Alinement

a. Set the receiver BAND SELECTOR to band 1. Connect Electronic Multimeter TS–505/U between pin 1 of V111 and ground (positive lead to ground).

b. Adjust L115 (fig. 118) for a maximum voltage reading (use alinement tool H379). Set the BAND SELECTOR to bands 2 through 7, adjusting coils L114 through L109 respectively (fig. 118). A minimum injection voltage of 5.4 volt must be maintained at the cathode of the second mixer (V112) for all bands.

110. R-f and Multiplier Alinement

a. Multiplier Stages. Remove the r-f unit from the receiver following the disassembly procedure in paragraph 17*e*. Remove the dust covers and disconnect P101 from J101. Replace the dust covers. For accurate results the alinement *must* be performed with the dust covers placed as for normal operation. Figure 92 shows access holes for alinement while figure 29 shows the turrets to be alined.

(1) Rotate the BAND SELECTOR to band 7. Connect Electronic Multimeter TS–505/U to P101. Rotate the TUNING dial to 233.5 mc. Adjust trimmers C211, C209, C205, and C119 (fig. 91) and the trimmer on Z128 for a maximum output as shown on the vtvm. Rotate the TUNING dial to 162.4 mc. Adjust the slugs of Z149, Z142, Z135, and Z128 for maximum output. (Paragraph 94*e* lists a cross reference chart of the subassemblies contained in each turret for each band.) Repeat the above procedure several times or until further adjustments result in negligible variations in meter readings.

Note. If, during the rotation of the TUNING control on any one of the seven bands, an abnormally high output on the vtvm is observed, the trouble is self-oscillation within the multiplier unit, usually caused by improper tracking.

(2) Rotate the BAND SELECTOR to band 6. Set the TUNING dial to 165.4 mc and adjust the trimmer on Z127 and the slugs of Z134, Z141, and Z148 for maximum output. Rotating the TUNING dial to 115.1 mc, again adjust the slugs of Z148, Z141, Z134, and Z127 for maximum output. Repeat this procedure several times, or until further adjustment of the trimmer on Z127 results in only a negligible change in output. Make a compromise adjustment of Z134 such that the output at both ends of the band are approximately equal.

(3) Rotate the BAND SELECTOR to band 5 and tune to 116.7 mc. Adjust the trimmer on Z126, and the slugs on Z147, Z140, and Z133 for maximum output. Set the TUNING dial to 81.2 mc and readjust the slugs on Z147, Z140, Z133, and Z126 for maximum. Repeat this procedure several times, or until further adjustment of the trimmer on Z126 results in only a negligible change in output. Make a compromise adjustment of Z133 for balance.

(4) Rotate the BAND SELECTOR to band 4 and tune to 82.7 mc. Adjust Z146, Z139, Z132, and Z125 for maximum output. Rotate the TUNING dial to 57.5 mc and again adjust Z146, Z139, Z132, and Z125 for maximum. (Compromise settings: Z125 and Z132.)

(5) Rotate the BAND SELECTOR to band 3 and tune to 58.4 mc. Adjust Z145, Z138, Z131, and Z124 for maximum output. Rotate the TUNING dial to 40.6 mc and again adjust Z145, Z138, Z131, and Z124 for maximum. (Compromise settings: Z124 and Z131.)

(6) Rotate the BAND SELECTOR to band 2 and tune to 41.4 mc. Adjust Z144, Z137, Z130, and Z123 for maximum output. Rotate the TUNING dial to 28.7 mc and again adjust Z144, Z137, Z130, and Z123. (Compromise settings: Z123 and Z130.)

(7) Rotate the BAND SELECTOR to band 1 and tune to 29.2 mc. Adjust Z143, Z136, Z129, and Z122 for maximum output. Rotate the TUNING dial to 20.3 mc and again adjust Z143,

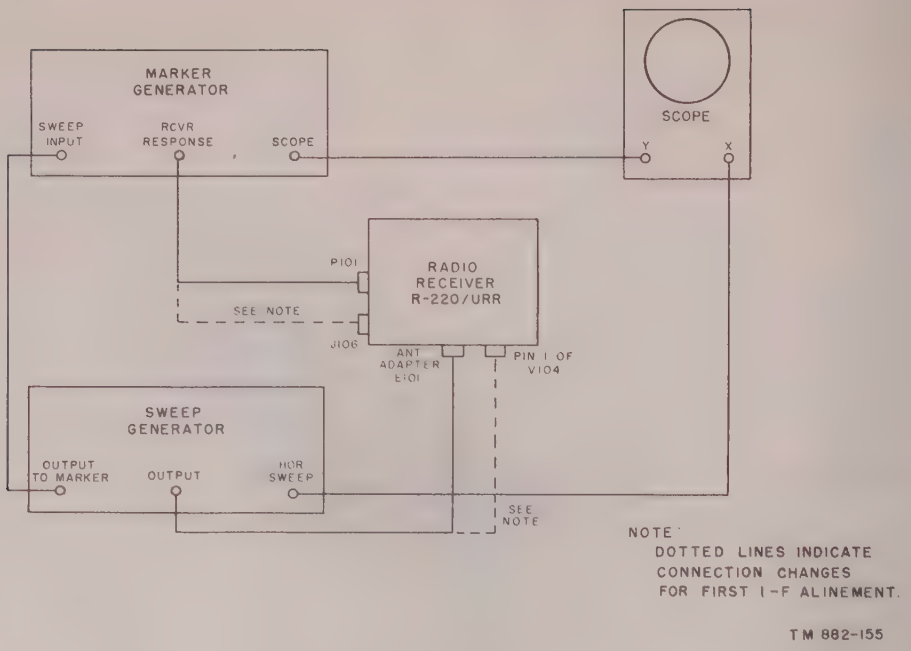

Figure 116. Test equipment set up for r-f and multiplier alinement.

Z136, Z129, and Z122 for maximum. (Compromise settings: Z122 and Z129.)

b. R-f Alinement. Disconnect the vtvm from P101 and connect P101 to a marker generator. Set up the test equipment as shown in figure 116.

(1) Rotate the BAND SELECTOR to band 1 and tune to 29.191 mc. Adjust the sweep-marker generator for a proper sweep and marker at 29.191 mc. Adjust the ANTENNA TRIMMER control (C101) and the trimmers on Z101, Z108, and Z115 for maximum output at marker frequency and correct waveshape as indicated on the scope (fig. 117). Rotate the TUNING dial to 20.302 mc and adjust the sweep-marker generator for 20.302 mc. Adjust slugs on Z101, Z108, and Z115 for maximum output and as close to the correct waveshape as possible. At this point consult the waveshape chart, and determine if the coupling is correct.

(2) If overcoupling exists at *either* end of the band, tune the receiver and test equipment for that end of the band which shows the greatest degree of overcoupling. Adjust the coupling links of the coils for that band on turrets Z151 and Z152 by moving them along the form *away* from the coil winding. This adjustment should be made in small steps, moving each link approximately the same amount, until the desired waveshape is obtained. Minor retuning may be required after this adjustment.

(3) If undercoupling exists at *both* ends of the band, tune the receiver and test equipment for that end of the band which most closely approximates the desired waveshape. Adjust the coupling links of the coils for that band on turrets Z151 and Z152 by moving them along the form *toward* the center of the coil winding. This adjustment should be made in small steps, moving each link approximately the same amount, until the desired waveshape

Band	High end		Low end	
	Frequency (mc)	Adjustments	Frequency (mc)	Adjustments
1	29.191	C101 Z101 Z108 Z115	20.302	Z101 Z108 Z115
2	41.371	C101 Z102 Z109 Z116	28.773	Z102 Z109 Z116
3	58.382	C101 Z103 Z110 Z117	40.604	Z103 Z110 Z117
4	82.742	C101 Z104 Z111 Z118	57.546	Z104 Z111 Z118
5	116.764	C101 Z105 Z112 Z119	81.208	Z105 Z112 Z119
6	165.484	C101 Z106 Z113 Z120	115.092	Z106 Z113 Z120
7	220.192	C101 Z107 Z114 Z121	170.192	Z107 Z114 Z121

is obtained. Minor retuning may be required after this adjustment.

(4) The links on turret Z150 have been correctly adjusted and cemented in place. They require no adjustment.

(5) After coupling adjustments are completed, readjust the trimmers and slugs for that particular band as in (1) *(a)*. It may become necessary to repeat the entire procedure several times in order to obtain the desired waveshape.

(6) Following the outlined procedure (subpars. (1) through (5) above) aline each turret at the frequencies listed in the chart.

(7) Reconnect P101 to J101 and disconnect all test equipment.

111. First I-f Alinement

a. Set the receiver front panel controls to the positions listed in paragraph 107*b*. Set up the test equipment as shown in figure 116 using the alternate set-up indicated by dotted lines. Rotate the BAND SELECTOR to band 1. Remove the second high frequency oscillator tube V111 and turret Z152. (The output of the sweep generator is coupled to the grid of V104 through the wiper for Z152.) Adjust marker generator and sweep generator output to 6.0942 mc and sweep generator output for 1 mc sweep width.

Note. The output at J106 is r-f, thus requiring that a detector be used with the scope.

b. Adjust L146, L147, L160, and L161 (fig. 118) for a symmetrical response curve with the 6.0942 mc marker at the center (fig. 117). Re-

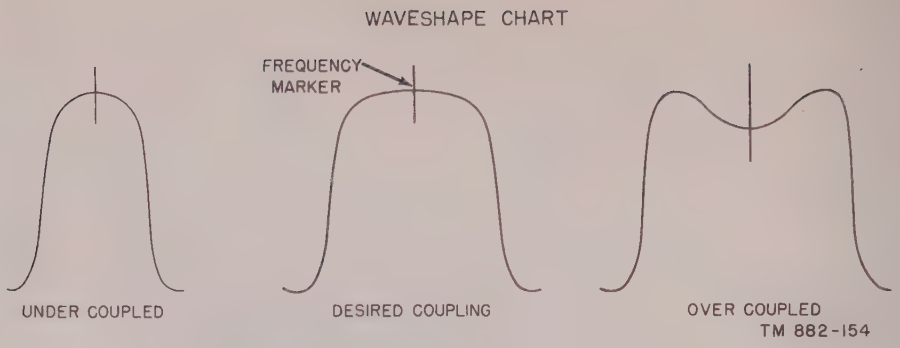

Figure 117. Waveshape chart.

peat this procedure until the proper curve is obtained.

c. Change the frequency of the marker generator to 8.6369 mc and set the BAND SELECTOR to band 2. Adjust L144, L145, L158, and L159 for a symmetrical response curve (fig. 117).

d. Follow the procedure outlined in subparagraphs *a*, *b*, and *c*, when alining the first i-f stage. The following chart lists frequencies and alinement points for each band.

Band	Center frequency (mc)	Alinement points
1	6.0942	L146, L147, L160, L161
2	8.6369	L144, L145, L158, L159
3	12.1884	L142, L143, L156, L157
4	17.2738	L140, L141, L154, L155
5	24.3767	L138, L139, L152, L153
6	34.5476	L136, L137, L150, L151
7	48.7535	L134, L135, L148, L149

112. Discriminator Alinement

a. Set the receiver front panel controls as outlined in paragraph 107*b*. Change the SELECTIVITY control to 200 K.C. and the OPERATION control to FM SQUELCH. Connect Electronic Multimeter TS–505/U to the output of the discriminator; junction of R355 and R356 on TB304. Set vtvm scale to +3 volts d-c. Connect Signal Generator AN/URM–25 to the grid of the third mixer V301. Remove the 2205-kc crystal Y301.

b. Adjust the signal generator for 100 microvolts output at 355 kc. Because accuracy is important, check the output of the signal generator using Frequency Meter Set SCR–211. Adjust Z301 (using alinement tool provided at rear of receiver) for maximum positive d-c voltage.

c. Change the frequency of the signal generator to 555 kc. (Check frequency with frequency meter.) Set the vtvm scale to —3 volts d-c. Adjust Z302 for maximum negative d-c voltage.

d. Change the frequency of the signal generator to 455 kc and adjust C350 for zero volts on the vtvm.

e. Repeat the procedure outlined in subparagraphs *b*, *c*, and *d*. Change the frequency of the signal generator to 380 kc and note the voltage reading. Change the frequency of the signal generator to 530 kc and note the voltage reading. These voltages must read a minimum of 1 volt and be within .5 volt of each other.

f. Replace the 2205-kc crystal Y301.

113. Beat Frequency Oscillator Alinement

a. Connect Signal Generator TS–497/URR to the antenna input of the receiver through adapter E101 and a dummy antenna. Set the receiver front panel controls as outlined in paragraph 107*b*. Adjust the signal generator for 30 mc at 50 microvolts, unmodulated. Connect the headset to AUDIO OUTPUT jack J305.

b. Set the B.F. OSCILLATOR to "0" position. Adjust C408 (fig. 78) to a zero beat. Rock the B.F. OSCILLATOR control to each side of the "0" position. At the extreme end of the range on either side of the "0" position the frequency of the audio note should be 3 to 4 kc.

114. Meter Alinement

a. CARRIER Position. Rotate the OPERATION switch to the AGC position. Connect Sig-

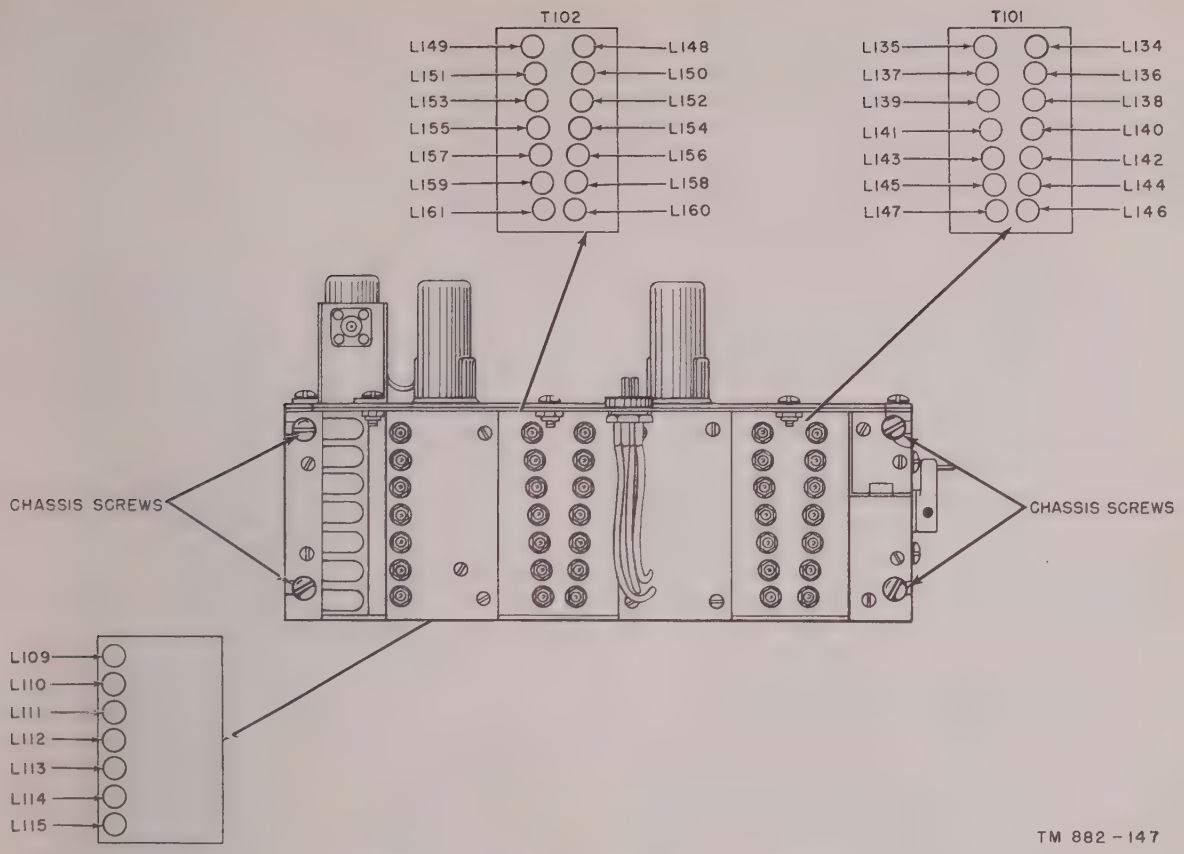

Figure 118. R-f unit, i-f section alinement points.

nal Generator TS–497/URR to the receiver antenna input through adapter E101 and a dummy antenna. Connect Electronic Multimeter ME–6A/U to terminals 1 and 2 of TB308. Adjust the signal generator for 50 uv (microvolts) output at 30 mc, amplitude modulated 30 percent at 400 cycles. Adjust the ANTENNA TRIMMER for maximum output. The receiver panel meter should read 0 db. If the meter reads other than 0, adjust R429 until the required reference is obtained.

b. OUTPUT LOW Position. Connect Output Meter TS–585/U to terminals 3 and 6 of TB308. Set the input impedance to 600 ohms. Connect the signal generator to the antenna input through adapter E101 and a dummy antenna and adjust for 5 uv output at 30 mc, amplitude modulated 30 percent at 400 cycles. Set the METER switch to the OUTPUT LOW position. Rotate AUDIO GAIN 1 and AUDIO GAIN 2 controls for an output of 1 mw (milliwatt). Receiver front panel meter reads 0 dbm.

c. OUTPUT HIGH Position. Follow the same procedure outlined in the preceding subparagraph. Set the METER switch to OUTPUT HIGH. Receiver front panel meter reads 0 dbm.

d. LIMITER Position. Adjust the generator for an output of 5 uv at 30 mc, unmodulated. Set the receiver METER switch to LIMITER and the OPERATION switch to FM SQUELCH. With R.F. GAIN–SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 set to maximum, the meter reads approximately 15 ua (microamperes).

e. DISC Position. Disconnect the output meter and the signal generator; ground the balanced antenna input. Set the R.F. GAIN–SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls to maximum. Set the OPERATION switch to FM SQUELCH and the METER switch to DISC. With a rushing noise heard at the headset, adjust R420 for a zero (0) reference (mid-scale deflection) on the meter.

115. Calibrator Oscillator Alinement

Turn the CALIBRATOR switch to ON. Connect the vtvm to pin 1 (grid) of V114. Adjust L124 (using alinement tool supplied with receiver) for maximum grid voltage on V114. Adjust Frequency Meter Set SCR-211 for 5mc; loosely couple the output of the grid circuit of V115 to the frequency meter, adjust C198 until the frequency matches that of the frequency meter.

Section IV. FINAL TESTING

116. General

This section is intended as a guide to be used in determining the quality of a repaired Radio Receiver R–220/URR. The minimum test requirements, outlined in the following paragraphs, may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation. Equipment not meeting the requirements should be considered as defective and requiring further maintenance.

117. Test Equipment and Preliminary Adjustments

a. General. The test equipment listed in subparagraph *b* is necessary to complete the final testing. However, if the particular type mentioned is not available, an equivalent may be used. When using a substitute, be sure the characteristics, such as input and output impedance, frequency range, etc., are the same. To insure positive results of all final tests make certain the source voltage applied to test equipment and Radio Receiver R–220/URR is exactly 115 volts a-c, unless otherwise specified. A dummy antenna consisting of a resistive network designed to match the signal generator output impedance and the receiver input impedance should be used.

b. Test Equipment.

(1) Output Meter TS–585/U

(2) Signal Generator TS–497/URR

(3) Audio Oscillator TS–382A/U

(4) Spectrum Analyzer TS–723/U

(5) Electronic Multimeter ME–6A/U

(6) Signal Generator SG–3/U

c. Receiver Controls. For each test, set the receiver front panel controls to the positions listed in this paragraph. When a test requires a different setting of the controls the new setting is indicated with the test.

(1) BAND SELECTOR to band 2.

(2) TUNING to 30 mc.

(3) B.F. OSCILLATOR to OFF.

(4) SELECTIVITY to 50 K.C.

(5) AUDIO RESPONSE to WIDE.

(6) R.F. GAIN–SQUELCH to approximate mid-position.

(7) AUDIO GAIN 1 and AUDIO GAIN 2 to approximate mid-positions.

(8) NOISE LIMITER to OFF.

(9) OPERATION to MGC.

(10) METER switch to CARRIER.

(11) CALIBRATE to OFF.

118. Audio Circuits

a. Over-all Audio Response.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator TS–497/URR, externally modulated by Audio Oscillator TS–382A/U to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for a 50 uv output at 30 mc, amplitude modulated 30 percent at 1,000 cycles by the external audio oscillator.

(3) *Tests.*

(a) Adjust the ANTENNA TRIMMER

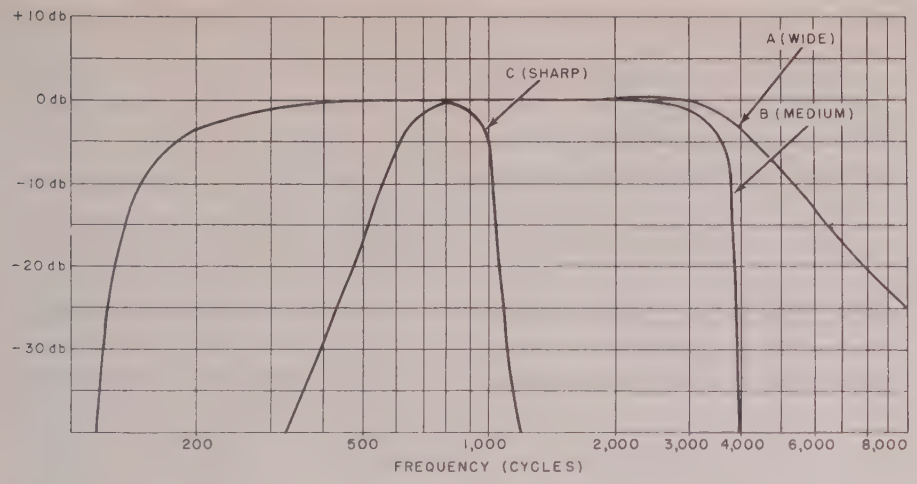

Figure 119. Audio response curves.

control on the receiver for a maximum output as indicated on the receiver front panel meter.

(b) Adjust the R.F. GAIN–SQUELCH control until an output of 10 db is indicated on the output meter. If the desired db level cannot be obtained by adjusting the R.F. GAIN–SQUELCH control, AUDIO GAIN 1 or AUDIO GAIN 2 may be adjusted to provide the proper db level.

(c) Disconnect the output meter and connect Spectrum Analyzer TS–723/U to terminals 1 and 2 of TB308. Shunt the TS–723/U with a 600-ohm resistor. Maintaining the signal input to the receiver and the percentage of modulation constant, vary the modulating frequency from 1,000 cycles to 150, 200, 400, 600, and every 200 cycles thereafter to 5,000 cycles. Record the db reading for each of the settings. The audio response curve cannot decrease from the initial reference level of 0 db at 1,000 cycles more than 1 db between 300 and 3,500 cycles and 3 db from 200 to 4,000 cycles; curve "A" of figure 119.

(d) Set the receiver AUDIO RESPONSE switch to MEDIUM. Repeat the entire test procedure, recording db readings for each frequency. The audio response curve (B, fig. 119) cannot decrease from the initial reference level more than 1 db between 300 and 3,000 cycles and 3 db between 200 and 3,500 cycles. The response must be at least 35 db down at 4,000 cycles.

(e) Set the receiver AUDIO RESPONSE switch to the SHARP position. Repeat the entire test procedure, recording db readings for each frequency. The audio response curve (C, fig. 119) now has a new reference of 0 db at 800 cycles. The band pass at 6 db down shall be between 600 and 1,000 cycles and at 30 db down shall be between 400 and 1,200 cycles.

b. Audio Power Output.

(1) *Receiver controls.* Set the receiver front panel controls as outlined in paragraph 117*c*. Rotate the BAND SELECTOR to band 7 and tune to 230 mc. Set the SELECTIVITY control to the 10 K.C. position and the AUDIO RESPONSE switch to MEDIUM. Rotate the R.F. GAIN–SQUELCH, AUDIO GAIN 1 and

AUDIO GAIN 2 controls to maximum.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set the impedance setting to 600 ohms. Connect Signal Generator TS–497/URR externally modulated by Audio Oscillator TS–382A/U to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for a 10 uv output at 230 mc, amplitude modulated 30 percent at 1,000 cycles by the external audio oscillator.

(3) *Tests.*

(a) Adjust the ANTENNA TRIMMER control for a maximum output as indicated on the output meter. The power output must be at least 500 mw.

(b) Set the SELECTIVITY control to the 50 K.C. position and readjust the ANTENNA TRIMMER control for a maximum output as indicated on the output meter. The power output must be at least 500 mw.

(c) Set the SELECTIVITY control to the 200 K.C. position and readjust the ANTENNA TRIMMER control for a maximum output as indicated on the output meter. The power output must be at least 500 mw.

(d) Return SELECTIVITY control to the 10 K.C. position.

(4) *Audio power output with bfo.* Follow the procedure outlined in paragraph 118*g*(1) and (2) with the following exceptions:

(a) Turn B.F. OSCILLATOR to ON.

(b) Disconnect the audio oscillator.

(c) Reduce the r-f signal generator output from 10 uv to 5 uv. Perform the test outlined in paragraph 118*b*(3).

c. Audio Harmonic Distortion, A-m Operation.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Set the AUDIO RESPONSE switch to MEDIUM. OP SWITCH TO AGC

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set the impedance setting to 600 ohms. Connect Signal Generator TS–497/URR, externally modulated by Audio Oscillator TS–382A/U, to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for a 50 uv output at 30 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.*

(a) Adjust the ANTENNA TRIMMER control on the receiver for a maximum output as indicated on the output meter. Increase the settings of R.F. GAIN–SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 controls until an output of 500 mw is indicated on the output meter. Disconnect the output meter and connect Spectrum Analyzer TS–723/U. (Set up to measure harmonic distortion.)

(b) Set the meter switch of the distortion meter to distortion and measure the percentage. (It should not exceed 10 percent.)

(c) Reconnect the output meter and readjust R.F. GAIN–SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 controls for an output of 10 mw. Repeat the procedures of paragraph 118*c*(3)*(a)* and *(b)*. The distortion percentage shall not exceed 5 percent.

d. Audio Harmonic Distortion, F-m Operation.

(1) *Receiver controls.* Set the receiver front panel controls to the same positions as in paragraph 117*c*. Rotate the SELECTIVITY switch to 200 K.C., the OPERATION switch to FM SQUELCH, and the AUDIO RESPONSE switch to MEDIUM.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2

of TB308. Set the input impedance to 600 ohms. Connect Signal Generator SG–3/U to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for 50 uv output unmodulated at 30 mc. Adjust the TUNING control for maximum quieting of the receiver. Modulate the signal generator with 400 cycles at 75 kc deviation.

(3) *Tests.*

(a) Adjust the ANTENNA TRIMMER control for a maximum output as indicated on the output meter. Turn the R.F. GAIN–SQUELCH control fully clockwise. Increase the settings of the AUDIO GAIN 1 and AUDIO GAIN 2 controls for 10 mw output.

(b) Disconnect the output meter and connect Spectrum Analyzer TS–723/U. Set the meter for measuring harmonic distortion. Turn the meter switch on the distortion meter to the distortion position and measure the percentage while varying the frequency deviation from 5 to 75 kc. (It should not exceed 4 percent.)

e. Audio Hum Level.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the OPERATION switch to AGC and the AUDIO GAIN 1 and AUDIO GAIN 2 controls to ~~maximum~~. MID POSITION.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator AN/URM–25 to the receiver balanced input through adapter E101 and a dummy antenna. Adjust the signal generator for an ~~unmodulated~~ output of 1,000 uv at 30 mc., 30% at 400 Hz

(3) *Tests.* Adjust the ANTENNA TRIMMER for maximum ~~and record the output~~. Disconnect the output meter and connect Spectrum Analyzer TS–723/U; tune the meter to the *hum frequency*. The hum level shall be a minimum of 50 db below the audio output level.

119. I-f Circuits

a. Image Rejection Ratio.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and tune to 20 mc.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set the input impedance to 600 ohms. Connect Signal Generator TS–497/URR to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for a 10 uv output at 20 mc, amplitude modulated 30 percent at 400 cyeles.

(3) *Tests.*

(a) Adjust the ANTENNA TRIMMER control for a maximum output. Adjust the R.F. GAIN–SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 controls for 10 mw output. Change the frequency of the signal generator to 7.8116 mc (image frequency) and increase the output until a power output of 10 mw is again obtained. The ratio of inputs must be at least 80 db.

Caution: While tuning the signal generator to the image frequency, the receiver controls must be left untouched at the test frequency.

(b) Using the previously outlined procedure, check the image rejection ratio at each of the test frequencies listed in the following table.

Test frequency (mc)	Image frequency (mc)	Minimum ratio (db)
34	16.7262	80
48	23.6232	80
~~68~~ 35	~~34.4524~~	80
~~98~~ 106	~~49.2466~~	80
~~140~~ 150	~~70.9048~~	80
200	102.4930	80

b. I-f Rejection Ratio.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and tune to 20 mc.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set the input impedance to 600 ohms. Connect Signal Generator AN/URM–25 to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for 10 uv output at 20 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.*

(a) Adjust the ANTENNA TRIMMER for a maximum output. Adjust the R.F. GAIN–SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 controls for an output of 10 mw. Retune the signal generator for 455 kc, and increase its output until 10 mw is again obtained. The ratio of inputs must be at least 80 db.

(b) Retune the signal generator to 1.75 mc, and increase its output until a power output of 10 mw is again obtained. Again the ratio must be at least 80 db.

(c) Retune the signal generator to 6.0942 mc and increase its output until a power output of 10 mw is obtained. The ratio must be at least 80 db.

(d) Using the previously outlined procedure, check the i-f rejection ratio at each of the test frequencies listed in the following table. In all cases the minimum ratio will be 80 db.

Note. At higher frequencies it will be necessary to use Signal Generator TS–497/URR.

Band	Receiver frequency (mc)	Signal generator frequency (mc)
1	20	.455
1	20	1.75
1	20	6.0942
2	34	.455
2	34	1.75
2	34	8.6369
3	48	.455
3	48	1.75
3	48	12.1884
4	69	.455
4	69	1.75
4	69	17.2738
5	98	.455
5	98	1.75
5	98	24.3767
6	140	.455
6	140	1.75
6	140	34.5476
7	200	.455
7	200	1.75
7	200	48.7535

c. Spurious Response. SEE CHANGE #1

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and the SELECTIVITY control to the 10 K.C. position.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set the input impedance to 600 ohms. Connect Signal Generator AN/URM–25 to the receiver antenna input through adapter E101 (fig. 5) and a dummy antenna (par. 117*a*). Adjust the signal generator for 10 uv at 20 mc, amplitude modulated 30 percent at 400 cycles. The output as indicated on the output meter is a reference level to be used in the remainder of this test.

(3) *Tests.*

(a) Retune the signal generator to 455 kc and increase the output to a level at least 80 db above reference level. Continuously tune the signal generator from 455 kc to 230 mc. At each spurious frequency indication, measure the ratio of input levels provided at the spurious frequency in relation to the reference level.

(b) Repeat the test for each setting of the SELECTIVITY control and for

each setting of the BAND SELECTOR. The rejection ratio of any spurious response shall be at least 60 db.

d. F-m Limiting.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the SELECTIVITY control to 200 K.C. and the R.F. GAIN–SQUELCH control to maximum. Set the OPERATION switch to the FM SQUELCH position.

(2) *Meter connections.* Connect Electronic Multimeter ME–6A/U to terminals 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator SG–3/U to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for 10 uv output at 30 mc, modulated by 400 cycles with 10 kc deviation.

(3) *Test.* Adjust the ANTENNA TRIMMER for maximum output. Adjust the receiver R.F. GAIN–SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for an output of 20 db. Increase the r-f output of the signal generator from 10 uv to .1 v. The receiver output must not rise more than 4 db above the reference level of 20 db.

120. R-f Circuits

a. Over-all Selectivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and tune to 24.2 mc. Set the SELECTIVITY switch to 200 K.C.

(2) *Meter connections.* Connect Electronic Multimeter ME–6A/U to terminals A and B of J301 (terminal B is ground). Set the meter to read a maximum of —10v d-c. Connect the signal generator to the receiver balanced antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for an unmodulated output of 10 uv at 24.2 mc.

(3) *Tests.*

(a) Adjust the ANTENNA TRIMMER for a maximum output. Adjust the R.F. GAIN–SQUELCH control for a reading of —5.0 volts on the vtvm. Increase the signal generator output to 20 uv and increase the frequency until the reference voltage of —5.0 volts is again obtained. Record the difference in frequency from the initial test frequency.

(b) Decrease the signal generator frequency until the reference voltage of —5.0 volts is again obtained. Record the difference in frequency from the initial test frequency.

(c) The preceding test shall be performed for each setting of the SELECTIVITY control and each of the following signal inputs: 10, 20, 100, 1,000, and 10,000 microvolts. Using the above outlined procedure, check the over-all selectivity of the receiver for the bandwidth requirements listed in the chart below at the following frequencies: 24.2 mc, 34.5 mc, 48.2 mc, 69.0 mc, 97.5 mc, 138.0 mc, and 196.0 mc.

Response ratio (db)	10 K.C.		50 K.C.		200 K.C.	
	Min. (kc)	Max. (kc)	Min. (kc)	Max. (kc)	Min. (kc)	Max. (kc)
6 (20 uv input)	8.5	11.5	42.5	57.5	170.0	230.0
20 (100 uv input)	17	19.5	76	87.4	290	333.5
40 (1,000 uv input)	27	31.0	116	133.4	416	478.5
60 (10,000 uv input)	36	41.4	155	178.2	540	621.0

b. AGC Characteristic.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Set the OPERATION switch to the AGC position and the AUDIO RESPONSE switch to MEDIUM.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator AN/URM–25 to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for 4 uv output at 30 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.*

(a) Adjust the ANTENNA TRIMMER for a maximum output. Adjust the R.F. GAIN–SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for 10 mw output (10 db). Increase the signal generator output from 4 uv to 1,000 uv. The maximum db rise (as shown on output meter) shall not exceed 3 db.

(b) Increase the signal generator output from 4 uv to .5 volt. The maximum db rise from the original reference level, shall not exceed 8 db.

c. Frequency Coverage.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and tune to 20.0 mc. Set the SELECTIVITY control to the 10 K.C. position.

(2) *Meter connections.* Connect Signal Generator AN/URM–25 to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for 50 uv at 20.0 mc, amplitude modulated 30 percent at 400 cycles. Increase the receiver gain controls until the signal is heard at the headset.

(3) *Tests.*

(a) Retune the signal generator to a frequency approximately 1 percent below the lowest frequency indicated on the dial for band 1 (19.8 mc). Retune the receiver until the signal is again heard. (Dial is not calibrated for 19.8 mc.)

(b) Retune the signal generator to a frequency approximately 1½ percent above the highest frequency indicated on the dial for band 1 (28.92 mc). Retune the receiver until the signal is again heard. (Dial is not calibrated for 28.92 mc.)

(c) The above outlined procedure checks the dial overlap for band 1 only. The dial overlap for the other six bands is 1½ percent for both the low and high ends of the band. Use the frequencies listed in the following chart:

Band	Low frequency (mc)	High frequency (mc)
1	19.80	28.92
2	28.07	41.10
3	39.89	57.85
4	56.14	82.21
5	79.78	115.71
6	112.29	164.43
7	159.57	233.45

121. Sensitivity Tests (EE ADDENDUM #2)

a. A-m Sensitivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Set the BAND SELECTOR to band 1 and tune to 20.01 mc. Rotate the AUDIO RESPONSE to MEDIUM and the R.F. GAIN–SQUELCH control to maximum.

(2) *Meter connections.* Connect Output Meter TS–585/U to pins 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator TS–497/URR to the receiver antenna input through adapter E101 and the dummy antenna. Adjust the signal generator for 2 uv output at 20.01 mc, modulated 30 percent at 400 cycles.

(3) *Tests.* The signal shall be tuned in on

the receiver with the ANTENNA TRIMMER adjusted for maximum output and the AUDIO GAIN 1 and AUDIO GAIN 2 controls adjusted for a 10 mw output with modulation, and 1 mw noise output with modulation removed. Using this procedure check the sensitivity of the receiver at the frequencies listed in the following chart. The signal input with these conditions shall be as indicated in the chart below.

Band	Receiver and generator frequency (mc)	Receiver input (uv)
1	20.010	2.0
1	24.250	2.0
1	28.480	2.0
2	28.520	2.0
2	34.500	2.0
2	40.200	2.0
3	40.700	2.0
3	49.000	2.0
3	56.700	2.0
4	57.300	2.0
4	69.000	2.0
4	80.600	2.0
5	81.400	2.0
5	97.000	2.0
5	113.500	2.0
6	114.000	3.5
6	138.000	3.5
6	161.000	3.5
7	163.000	6.0
7	196.000	6.0
7	229.000	6.0

b. F-m Sensitivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Set the BAND SELECTOR to band 1 and tune to 20.01 mc. Rotate the SELECTIVITY switch to 200 K.C. and the OPERATION switch to FM SQUELCH. Set the R.F. GAIN–SQUELCH control to maximum.

(2) *Meter connections.* Connect Output Meter TS–585/U to pins 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator SG–3/U to the receiver antenna input through adapter E101 and the dummy antenna. Adjust the signal generator for an output of 6.5 uv unmodulated at 20.01 mc. Adjust the TUNING control for maximum quieting of the receiver. Modulate the signal generator by 400 cycles with 10 kc deviation.

(3) *Tests.* The signal shall be tuned in on the receiver with the ANTENNA TRIMMER adjusted for maximum output and the AUDIO GAIN 1 and AUDIO GAIN 2 controls adjusted for 10 mw output with modulation, and 1 uw (microwatt) noise output with modulation removed. Using this procedure check the sensitivity of the receiver at the frequencies listed in the following chart. The signal input with these conditions shall be as indicated in the chart below.

Band	Receiver and generator frequency (mc)	Receiver input (uv)
1	20.010	6.5
1	24.250	6.5
1	28.480	6.5
2	28.520	6.5
2	34.500	6.5
2	40.200	6.5
3	40.700	6.5
3	49.000	6.5
3	56.700	6.5
4	57.300	6.5
4	69.000	6.5
4	80.600	6.5
5	81.400	6.5
5	97.000	6.5
5	113.500	6.5
6	114.000	6.5
6	138.000	6.5
6	161.000	6.5
7	163.000	16
7	196.000	16
7	229.000	16

c. Bfo Sensitivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and tune to 20.01 mc. Set the AUDIO RESPONSE switch to MEDIUM. Rotate the R.F. GAIN–SQUELCH control to maximum and the B.F. OSCILLATOR to 0.

(2) *Meter connections.* Connect Output Meter TS 585/U to terminals 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator TS 497/URR to the receiver antenna input through adapter E101 and the dummy antenna. Adjust the signal generator for 4 uv output at 20.01 mc with no modulation. Adjust the B.F. OSCILLATOR control for a 1,000 cycle tone.

(3) *Tests.* The signal shall be tuned in on the receiver with the ANTENNA TRIMMER adjusted for maximum output and the AUDIO GAIN 1 and AUDIO GAIN 2 controls adjusted for 10 mw output with the signal generator on and 1 mw noise output with the signal generator off. Using this procedure check the sensitivity of the receiver at the frequencies listed in the following chart. The signal input with these conditions shall be as indicated in the chart below.

Band	Receiver and generator frequency (mc)	Receiver input (uv)
1	20.010	1.0
1	24.250	1.0
1	28.480	1.0
2	28.520	1.0
2	34.500	1.0
2	40.200	1.0
3	40.700	1.0
3	49.000	1.0
3	56.700	1.0
4	57.300	1.0
4	69.000	1.0
4	80.600	1.0
5	81.400	1.0
5	97.000	1.0
5	113.500	1.0
6	114.000	1.5
6	138.000	1.5
6	161.000	1.5
7	163.000	2.0
7	196.000	2.0
7	229.000	2.0

d. Squelch Circuit.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117c. Rotate the SELECTIVITY switch to 200 K.C. and the OPERATION switch to AM SQUELCH.

(2) *Meter connections.* Connect a speaker to terminals 1 and 2 of TB308. Connect Signal Generator TS–497/URR to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for 50 uv output at 30 mc, modulated 30 percent at 400 cycles. Adjust the AUDIO GAIN 1 and AUDIO GAIN 2 controls for a comfortable listening level.

(3) *Tests.* The R.F. GAIN–SQUELCH control shall be rotated counterclockwise until the receiver squelches the incoming signal.

(a) The signal generator shall be adjusted for 1 uv output and the R.F. GAIN–SQUELCH control adjusted to the threshold level (point at which the incoming signal just overcomes the squelch). The R.F. GAIN–SQUELCH control shall be rotated counterclockwise until the signal is just squelched. The output of the signal generator shall be increased to 2 uv and the signal should be heard at the loudspeaker. With the signal generator output reduced to zero and the R.F. GAIN–SQUELCH control rotated completely counterclockwise the receiver noise should be squelched.

(b) The OPERATION switch shall be rotated to FM SQUELCH. With the R.F. GAIN–SQUELCH control completely counterclockwise the receiver noise should be squelched. The signal generator shall be adjusted for 10 uv output at 30 mc, modulated by 400 cycles with 15 kc deviation and with the R.F. GAIN–SQUELCH control rotated completely counterclockwise, the incoming signal should be squelched. The signal generator output shall be adjusted for 2 uv output and the R.F. GAIN–SQUELCH control adjusted to the threshold level. The R.F. GAIN–SQUELCH control should

then be rotated counterclockwise until the signal is just squelched. The output of the signal generator shall be increased to 6.5 uv and the signal should be heard at the speaker. With the signal generator output reduced to zero and the R.F. GAIN–SQUELCH control rotated completely counterclockwise the receiver noise should be squelched.

e. Noise Limiter Circuit.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*.

(2) *Meter connections.* Connect Signal Generator TS–497/URR to the receiver antenna input through adapter E101 and a dummy antenna. Connect Audio Oscillator TS–382A/U to the signal generator and also to Spectrum Analyzer TS–723/U. Adjust the signal generator for 10 microvolts output at 30 mc, externally modulated 30 percent at 400 cycles. Loosely couple the output lead from the analyzer to the output lead of the signal generator. Adjust the analyzer pulse generator for a 5 microsecond pulse at full output. Connect Panoramic Indicator IP–173/U to the grid (pin 7) of the first audio amplifier V317B. Adjust the scope controls to view the audio frequency containing pulses.

(3) *Tests.* With the NOISE LIMITER control turned to ON the pulses (as viewed on the scope) should be reduced to where they become invisible on the audio waveshape.

122. Auxiliary Circuits

a. Auxiliary I-f Output.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and tune to 24.250 mc. Set the AUDIO RESPONSE switch to MEDIUM. Rotate the R.F. GAIN–SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls to maximum.

(2) *Meter connections.* Connect Electronic Multimeter ME–6A/U to the auxiliary i-f connector J302. Connect Signal Generator TS–497/URR to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for 2 microvolts at 24.250 mc, modulated 30 percent at 400 cycles.

(3) *Tests.* The signal shall be tuned in on the receiver with the ANTENNA TRIMMER adjusted for maximum output and the R.F. GAIN–SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls adjusted for 1 mv output with modulation and 4.33 mv noise output with modulation removed. Using this procedure check the auxiliary circuit of the receiver at the frequencies listed in the following chart. The signal input with these conditions shall be as indicated in the chart below.

Band	Receiver and generator frequency (mc)	Receiver input (uv)
1	24.250	2
2	34.500	2
3	49.000	2
4	69.000	2
5	97.000	2
6	138.000	3.5
7	196.000	6.0

b. Auxiliary Diode Circuit.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and tune to 24.250 mc. Set the SELECTIVITY switch to 10 K.C. and the AUDIO RESPONSE switch to MEDIUM. Rotate the R.F. GAIN–SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for maximum.

(2) *Meter connections.* Connect Electronic Multimeter TS–505/U to terminals A and B (ground B) of J301. Connect Signal Generator SG-3/U to the receiver antenna input through a dum-

my antenna and adapter E101. Adjust the signal generator for an output of 2 uv at 24.250 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.* The signal shall be tuned in on the receiver, and with the ANTENNA TRIMMER adjusted for maximum the output should be 3 volts with modulation and 1.56 volts with modulation removed. Using this procedure check the auxiliary diode circuit for the frequencies in the following chart. The signal input with these conditions shall be as indicated in the chart below.

Band	Receiver and generator frequency (mc)	Receiver input (uv)
1	24.250	2
2	34.500	2
3	49.000	2
4	69.000	2
5	97.000	2
6	138.000	3.5
7	196.000	6.0

CHAPTER 7
SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

123. Disassembly

The following instructions are recommended as a guide for preparing the radio set for transportation and storage.

a. Disconnect the power cord from the a-c line.

b. Disconnect all outside field wire and coaxial cables from the receiving set.

c. Reel up all field wire and roll up all power cords.

d. Take down antenna and repack it. Follow instructions given in TM 11–5016.

124. Repacking for Shipment or Limited Storage

a. The exact procedure used in repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Refer to paragraph 16 and reverse the unpacking instructions as far as practicable.

b. Whenever practicable, place a dehydrating agent, such as silica gel, inside the case or carton which contains the receiver. Protect it with a waterproof paper barrier. Seal the seams with sealing compound or tape. Provide at least 3 inches of excelsior padding or some similar material between the paper barrier and the packing case.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

125. General

The demolition procedures outlined in paragraph 126 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commanding officer.

126. Methods of Destruction

a. Smash. Smash the crystals, controls, tubes, coils, turrets, switches, capacitors, and transformers, using sledges, axes, handaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut cords and wiring, using axes, handaxes or machetes.

c. Burn. Burn cords, resistors, capacitors, coils, turrets, wiring and technical manuals, using gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, cabinet and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Burn or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

g. Destroy. Destroy everything.

ABBREVIATIONS

a-c	alternating-current
adj	adjust, adjustment
a-f	audio-frequency
agc	automatic gain control
a-m	amplitude-modulated
amp	ampere
Ampl	amplifier
ANT	antenna
avc	automatic volume control
AWG	American Wire Gauge
b	bandwidth
bfo	beat frequency oscillator
C	centigrade
ccw	counterclockwise
coax	coaxial
cps	cycles per second
cw	clockwise
c-w	continuous-wave
db	decibel
dbm	audio power level referenced to 1 milliwatt of audio power developed across a 600-ohm load.
d-c	direct-current, direct-coupled
dblr	doubler
F	Fahrenheit
f-m	frequency-modulated
freq	frequency
ft	foot, feet
gnd	ground
h-f	high-frequency
hfo	high-frequency oscillator
h-v	high-voltage
i-f	intermediate-frequency
in.	inch, inches
k	kilo (1000)
kc	kilocycle
lb	pound, pounds
lo	local oscillator
ma	milliampere
max	maximum
mc	megacycle
meg	megohm
mgc	manual gain control
mh	millihenry
osc	oscillator
rcvr	receiver
r-f	radio-frequency
rms	root mean square
scrn	screen, screen grid
ss	setscrew
term.	terminal
ua	microampere
uf	microfarad
uh	microhenry
uhf	ultra-high frequency (300 to 3,000 mc)
uv	microvolt
uuf	micromicrofarad
v	volt, volts
vdcw	working voltage, d-c
vfo	variable-frequency oscillator
vhf	very-high frequency (30 to 300 mc)
vtvm	vacuum-tube voltmeter
w	watt, watts
WW	wire-wound
xtal	crystal.
Z, z	impedance

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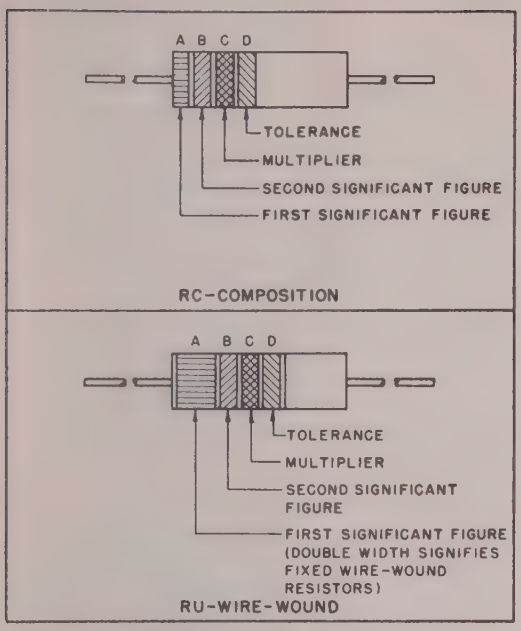
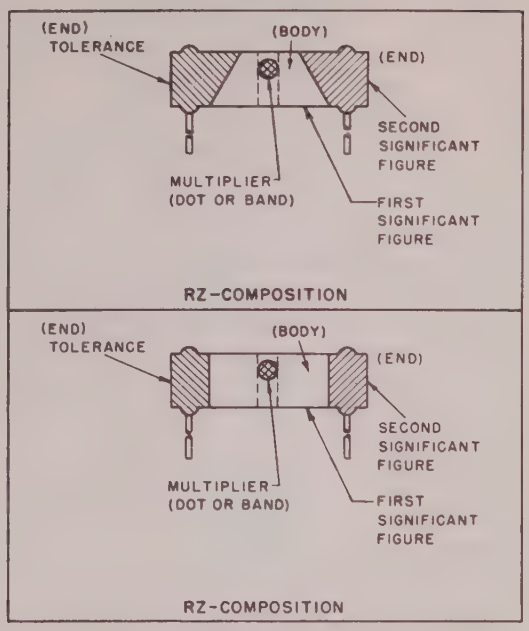
RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)



RADIAL-LEAD RESISTORS (UNINSULATED)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

* FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

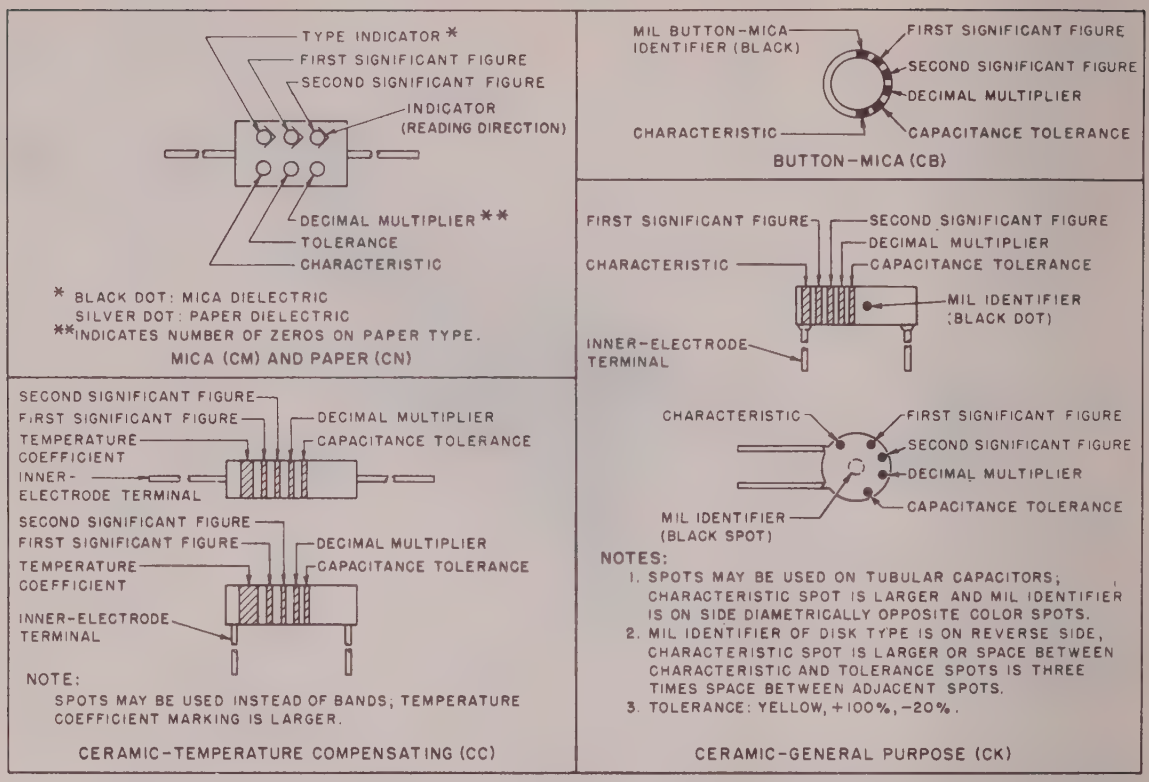
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

Figure 120. Resistor color code marking.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W*				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 121. Capacitor color code marking.

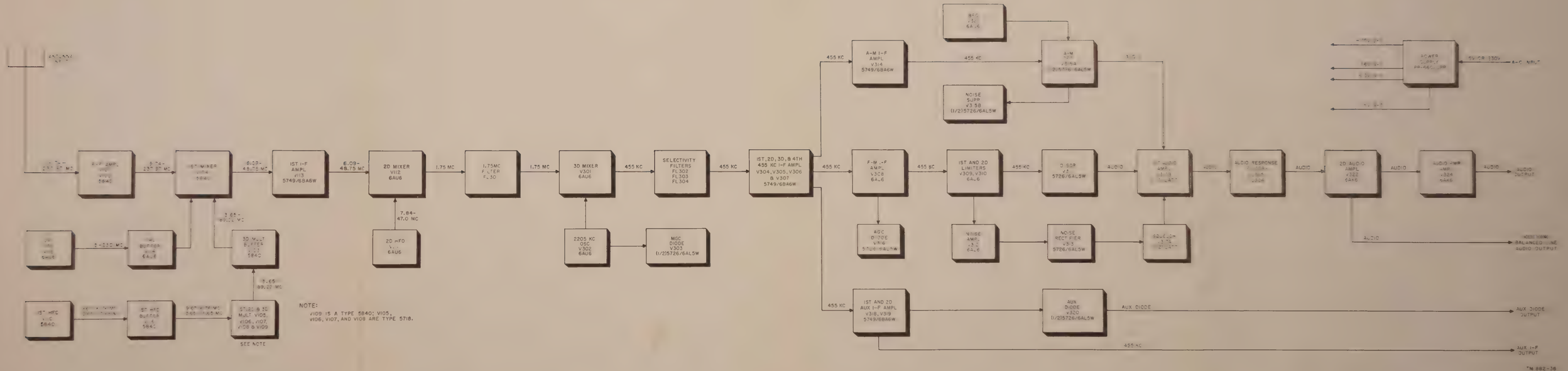

ANTENNA
1ST RF AMPL V102 5840
1ST MIXER V104 5840
6.09- 48.75 MC
IST I-F AMPL V13 5749/6BA6W
2D MIXER V112 6AU6
1.75 MC
1.75MC FILTER F-30
30 MIXER V301 6AU6
455 KC
SELECTIVITY FILTERS FL302 FL303 FL304
IST, 2D, 3D, & 4TH 455 KC I-F AMPL V304, V305, V306 & V307 5749/6BA6W
2205 KC OSC V302 6AU6
MGC DIODE V303 (1/215726/6AL5W)
7.84- 47.0 MC
2D HFO V111 6AU6
3.65 MC
3D MULT BLKTER V110 5840
IST HFO V109 5840
3.65 89.27 MC
SEE NOTE
NOTE:
V109 IS A TYPE 5840; V105, V106, V107, AND V108 ARE TYPE 5718.
A-M I-F AMPL V314 5749/6BA6W
BFO V315 6AU6
NOISE SUPP V3 58 (1/215726/6AL5W)
F-M I-F AMPL V308 6AU6
AGC DIODE V316 5749/6AL5W
IST AND 2D LIMITERS V309, V310 6AU6
NOISE AMPL V312 6AU6
NOISE RECTIFIER V313 5726/6AL5W
AUDIO
AUDIO RESPONSE
2D AUDIO AMPL V322 6AN5
AUDIO OUTPUT
IST AND 2D AUX I-F AMPL V318, V319 5749/6BA6W
AUX DIODE V320 (1/215726/6AL5W)
AUX DIODE
AUX DIODE OUTPUT
AUX I-F OUTPUT
POWER SUPPLY PP-1467/URR
115 VOLTS, 60 CYCLES A-C INPUT
BALANCED LINE AUDIO OUTPUT
TM 882-36

Figure 122. Radio Receiver R-320/URR, functional block diagram.

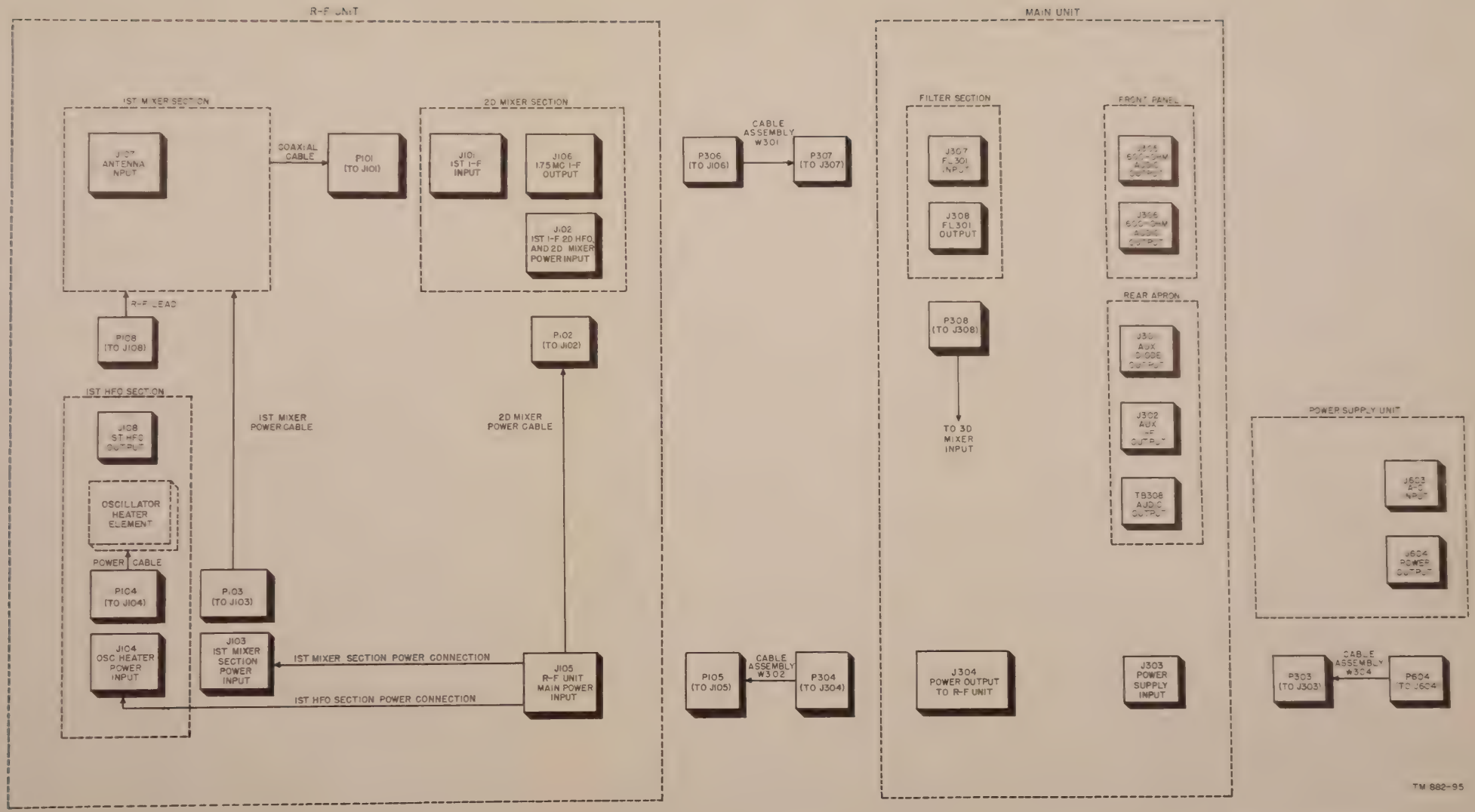


Figure 123. Cabling diagram.

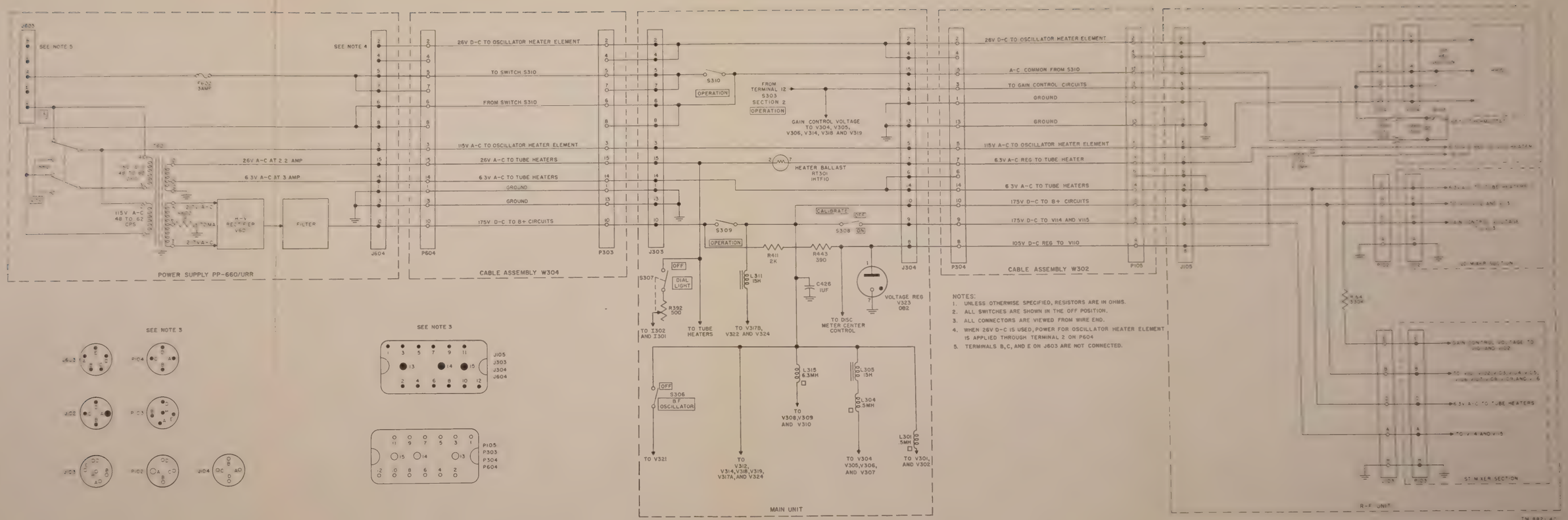


Figure 102. Cabling and power distribution

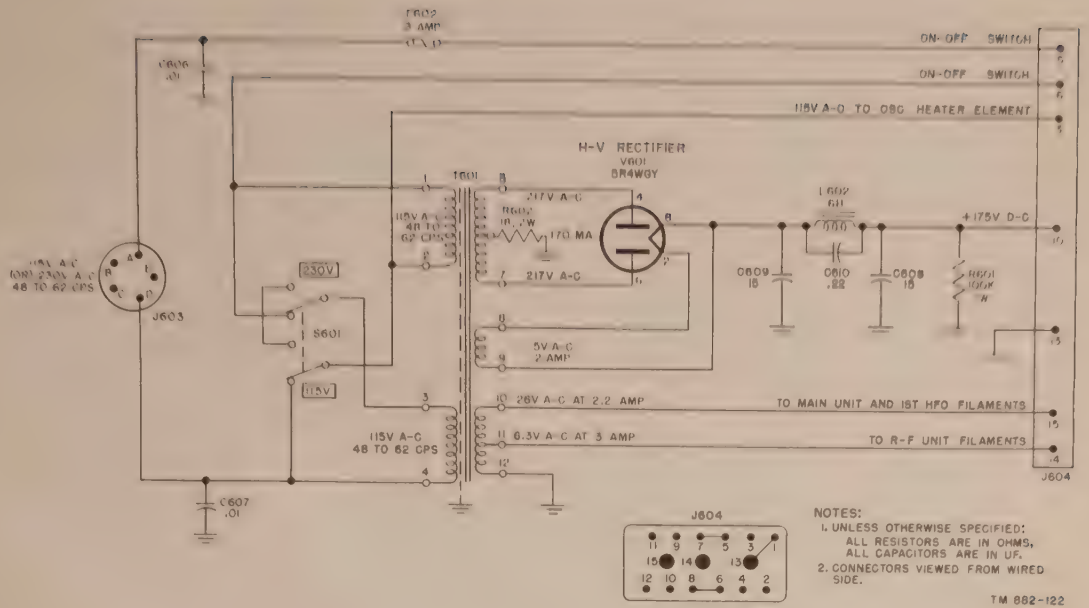


Figure 125. Power Supply PP-660/URR, schematic diagram.

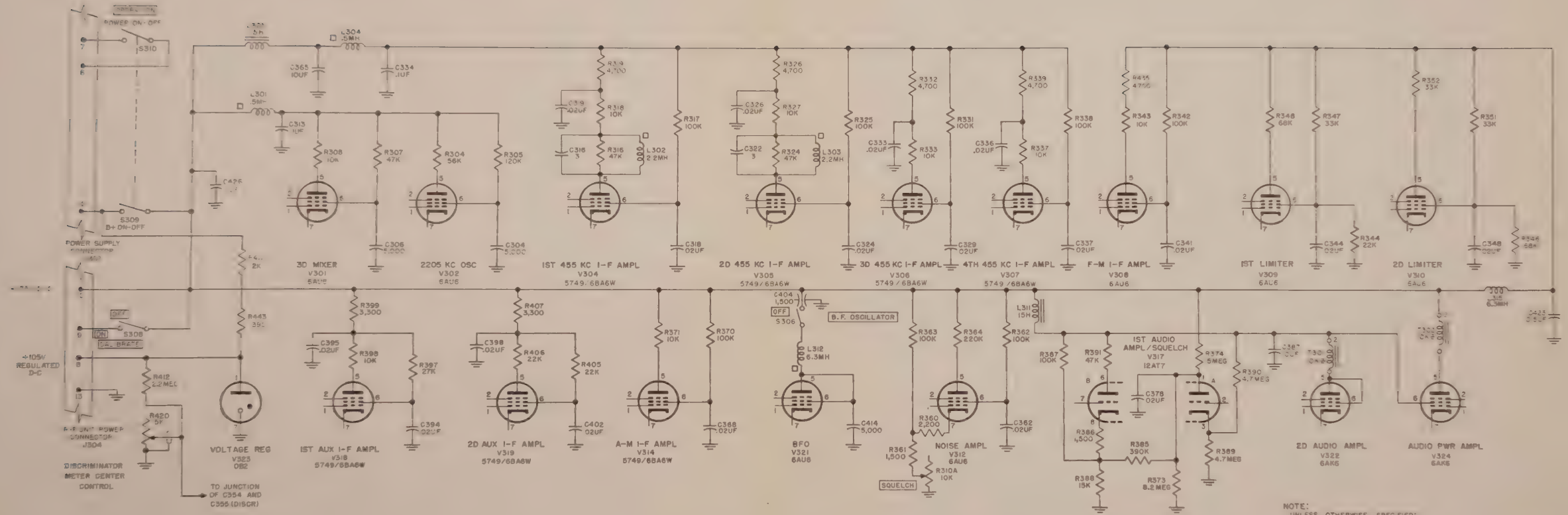


Figure 126. B+ distribution, main unit.

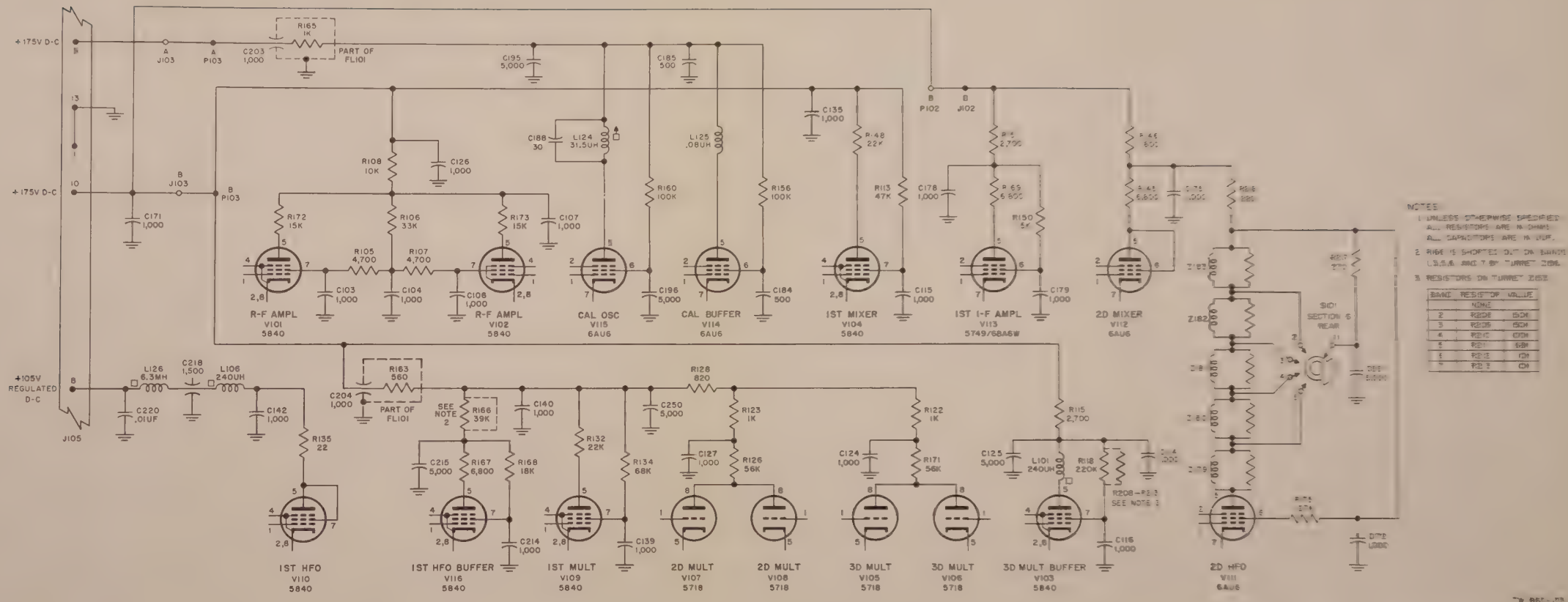
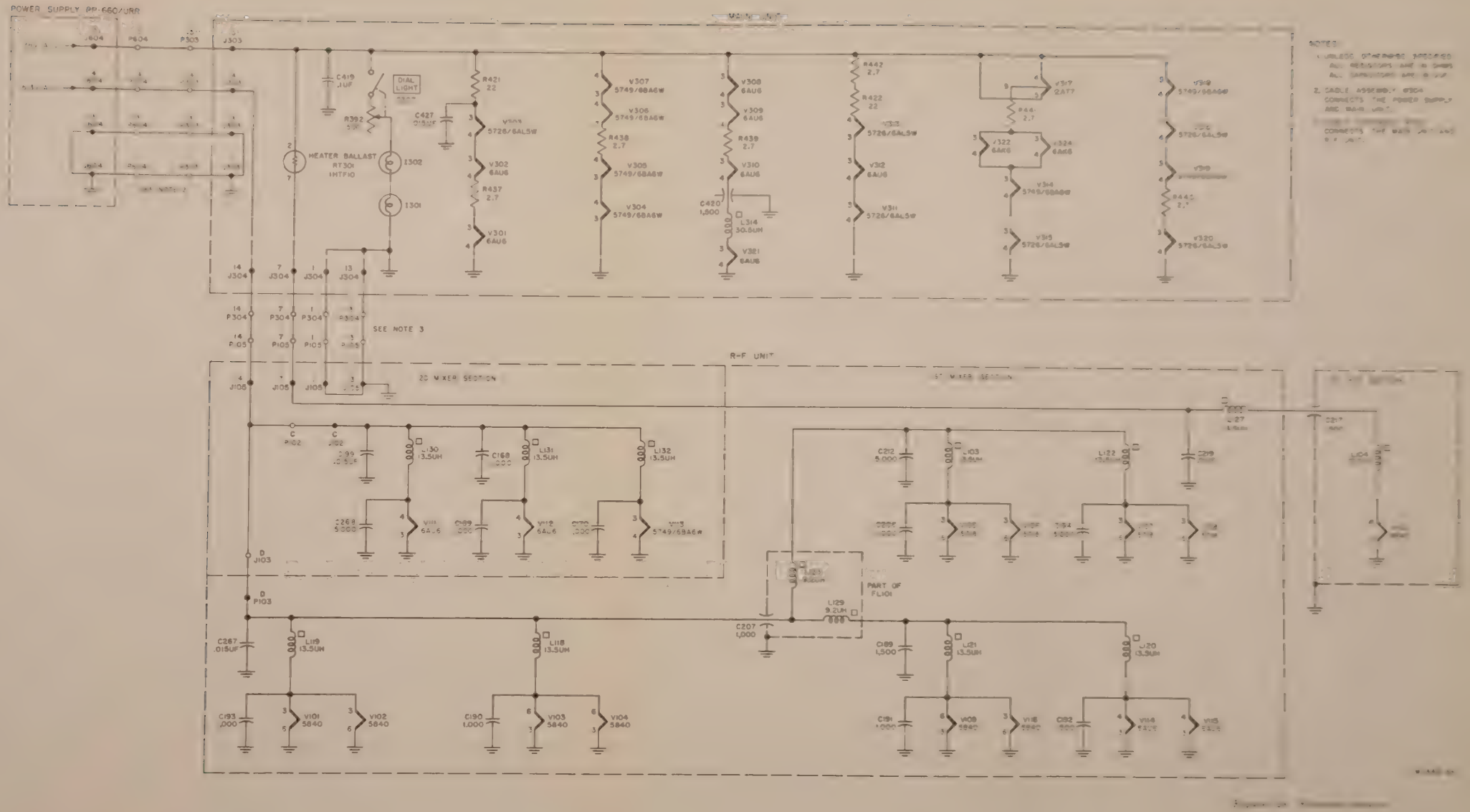


Figure 137. B+ distribution, r-f unit.


POWER SUPPLY PP-650/URR
J604
P604
P303
J303
C419 .1UF
DIAL LIGHT
R392 50K
C427 .015UF
HEATER BALLAST RT301 HMTF10
I302
I301
R421 22
V307 5749/6BA6W
V306 5749/6BA6W
R438 2.7
V305 5749/6BA6W
V304 5749/6BA6W
V308 6AU6
V309 6AU6
R439 2.7
V310 6AU6
C420 1,500
L314 30.0UH
V321 6AU6
R442 2.7
R422 22
V312 6AU6
V311 5726/6AL5W
V317 2AT7
R443 2.7
V322 6AM6
V324 6AM6
V314 5749/6BA6W
V315 5726/6AL5W
V319 5749/6BA6W
V320 5726/6AL5W
R445 2.7
J304
P304
P105
J105
SEE NOTE 3
R-F UNIT
2D MIXER SECTION
J103
P103
C267 .015UF
L119 13.5UH
L118 13.5UH
L130 13.5UH
L131 13.5UH
L132 13.5UH
C168 .000
C207 1,000
L129 9.2UH
PART OF FL101
C212 5,000
L103 3.6UH
L122
C219
C217
L104
C189 1,500
L121 13.5UH
L120 13.5UH
V101 5840
V102 5840
V103 5840
V104 5840
V108 5840
V116 5840
V114
V115

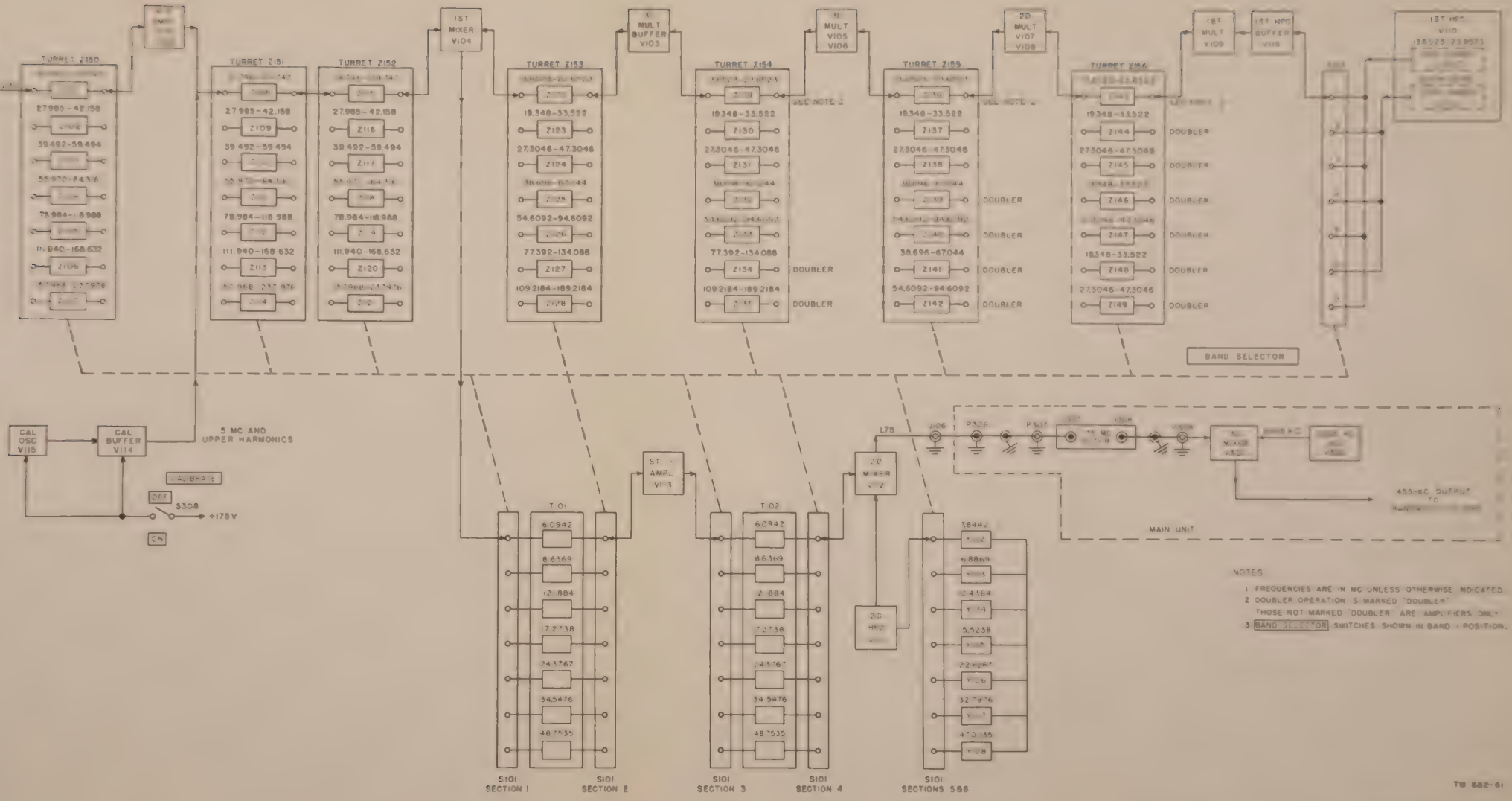


Figure 129. BAND SELECTOR, functional block diagram.

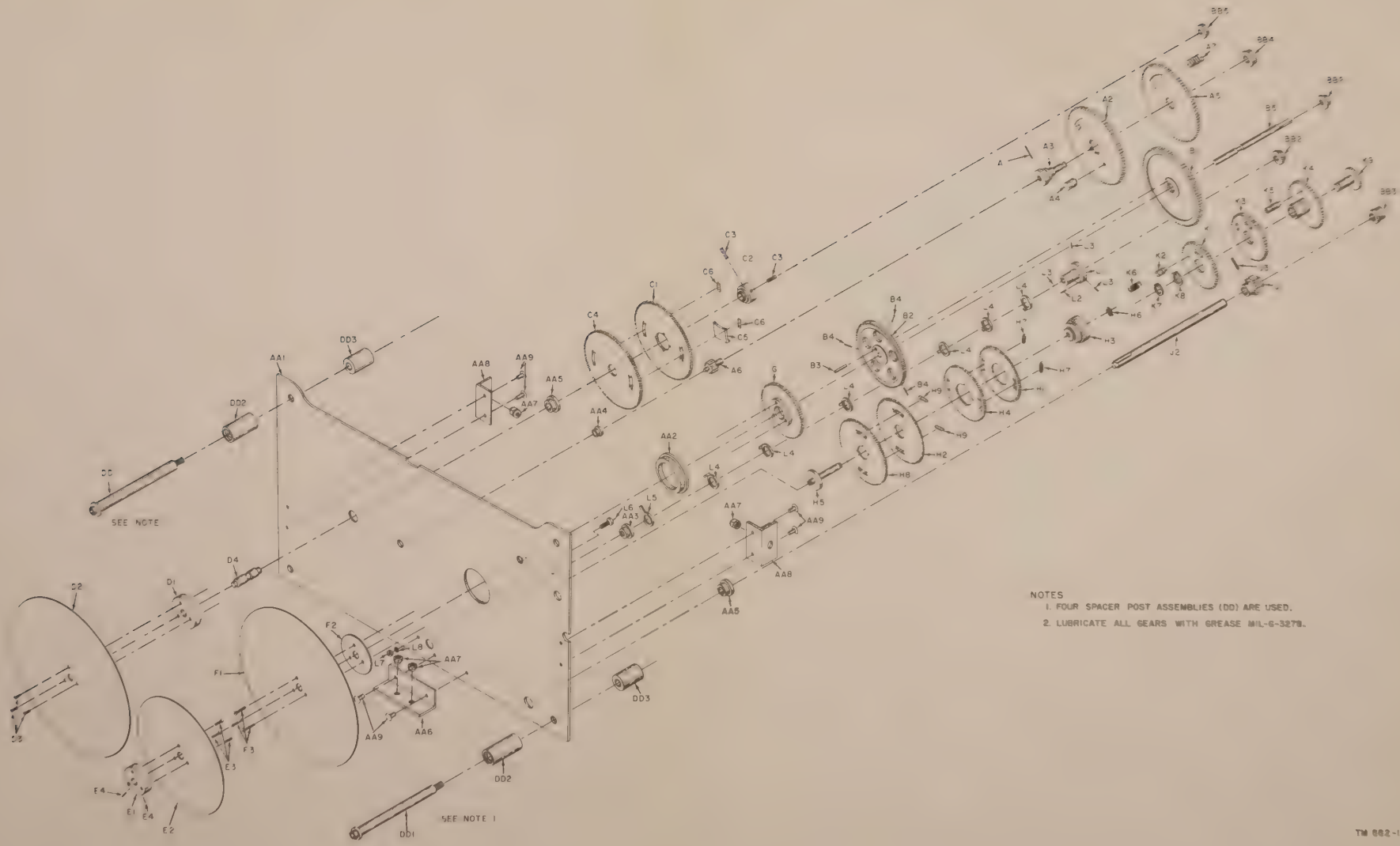


Figure 130. Control head, exploded view, assemblies A through L.

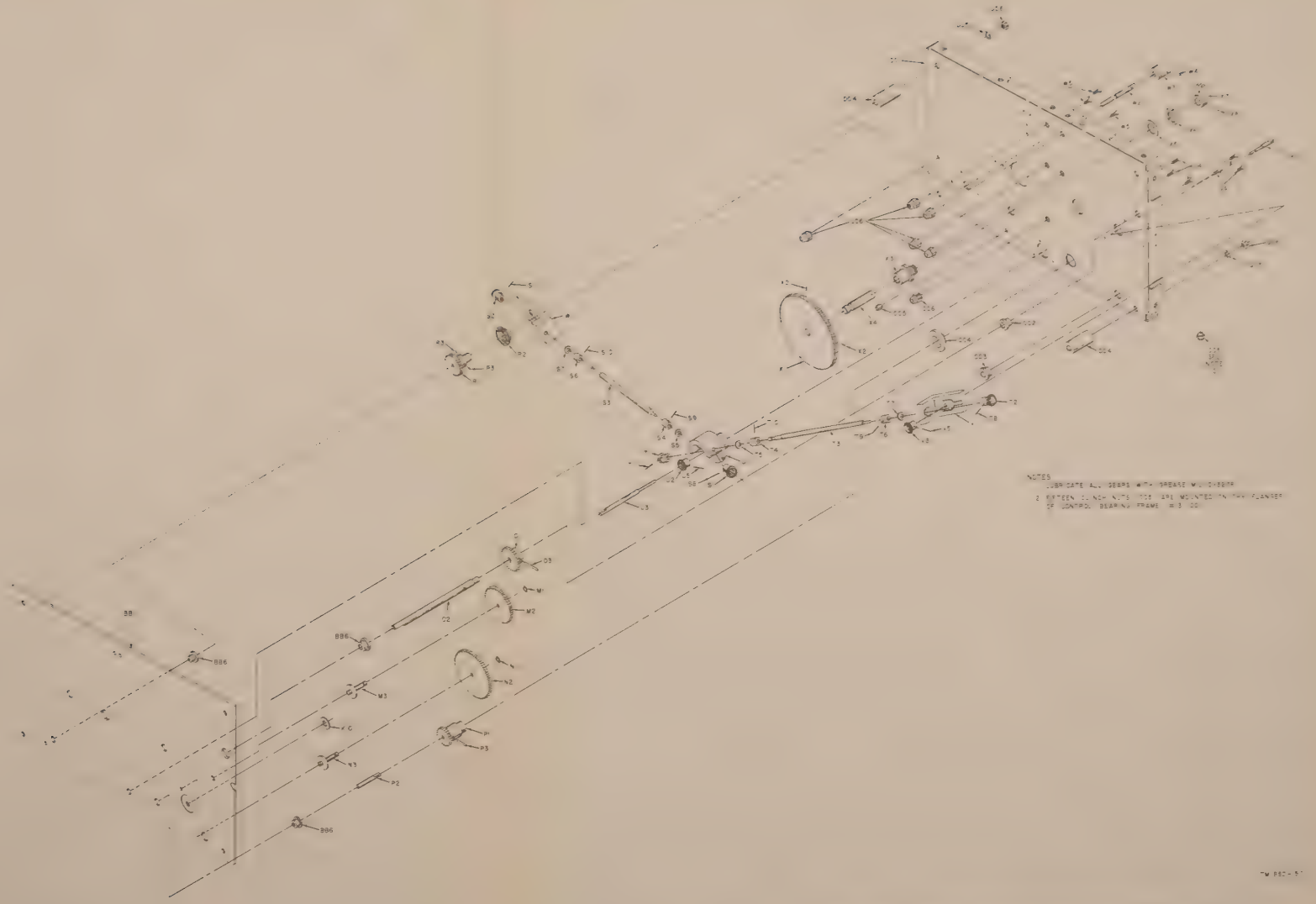
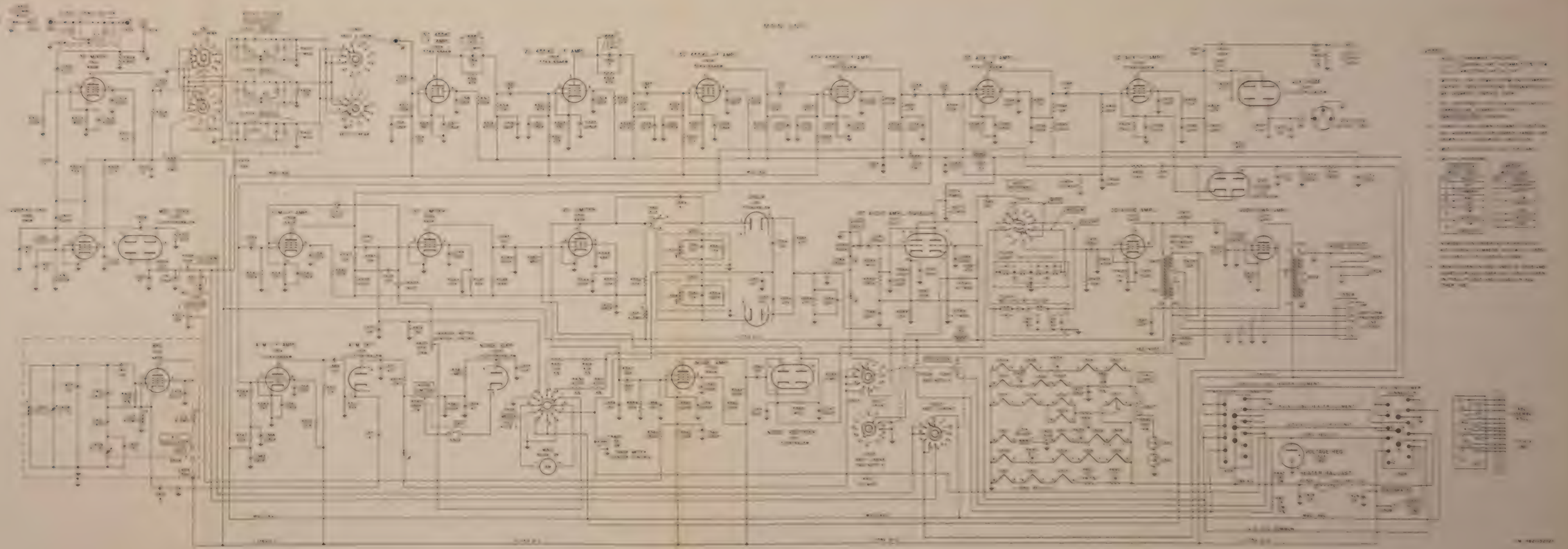
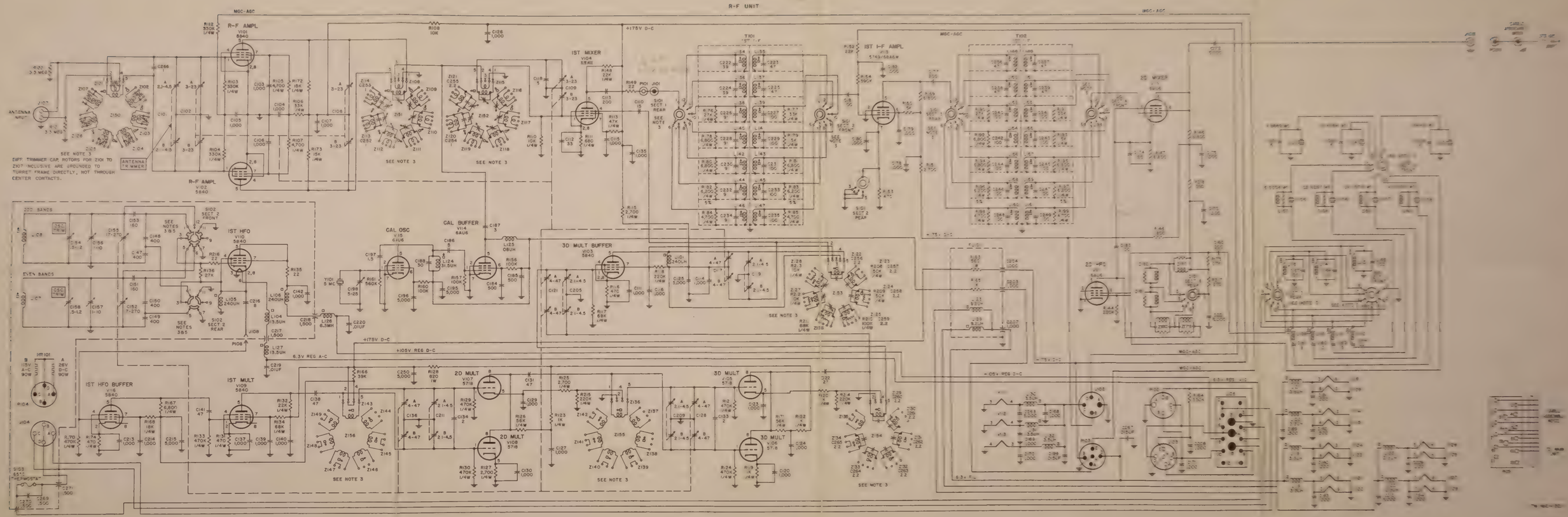


Figure 131. Control head, exploded view, assemblies M through X.



INSTRUMENT


R-F UNIT
AGC-AGC
R-F AMPL
V101
5840
R-F AMPL
V102
5840
SEE NOTE 3
DIFF. TRIMMER CAP ROTORS FOR Z101 TO Z107 INCLUSIVE ARE GROUNDED TO TURRET FRAME DIRECTLY, NOT THROUGH CENTER CONTACTS.
ANTENNA TRIMMER
IST MIXER
V104
5840
+175V D-C
IST I-F AMPL
V113
5749/5845W
2D MIXER
V106
6AU6
IST HFO
V110
5840
GAL OSC
V115
6AU6
GAL BUFFER
V114
6AU6
3D MULT BUFFER
V105
5840
2D HFO
V112
6AU6
IST HFO BUFFER
V116
5840
IST MULT
V109
5840
2D MULT
V107
5718
2D MULT
V108
5718
3D MULT
V104
5718
3D MULT
V103
5718
+105V REG D-C
6.3V REG A-C
SEE NOTE 3
SEE NOTES 3&5
SEE NOTES 3&5
SEE NOTE 3
SEE NOTE 3
SEE NOTE 3

SIGNAL CORPS ADVANCE MAINTENANCE PARTS LIST

Organizational Maintenance Allowances
Field and Depots Maintenance Stockage Guide

FOR

EQUIPMENT RECEIVER RADIO R-220/URR

DATE 5 May 1954

Based on 7300 hours of operation per year

GENERAL NOTES:

This document includes those maintenance parts normally expected to fail during the first years operation. It may be used for requisitioning purposes until receipt of the SIG 7 and 8 Supply Manual. Upon receipt of the SIG 7 and 8 Supply Manual the Advance Maintenance Parts List should be destroyed.

Those spare parts items not authorized for stockage by using organizations, but which may be obtained through normal requisitioning procedures for immediate use only, where a repair operation involving the part is considered practicable, are indicated by a percent symbol (%) in the appropriate column.

The consumption rates given in this document for tubes are conservative theoretical estimates, and are provided for use only where no better information, such as data based on operating experience, is available. These figures are based on levels and requirements for equipment actually in use, not on authorizations or equipment stored in depots.

The Federal Stock Number column lists the 11-digit Federal Stock Number (or 7-digit Federal Item Identification Number) which has been assigned by the Office of Cataloging, DSMA. These numbers are for information only and will not be used in connection with supply operations until such time as implementation of the Federal Cataloging Program is accomplished.

ORDER INFORMATION

Model	Order Number	Manufacturer
	116-P-52	Motorola

MAINTENANCE ENGINEERING BRANCH. SCEL

268P3569

SIGNAL CORPS STOCK NUMBER	FEDERAL STOCK NUMBER	REFERENCE SYMBOL	DESIGNATION BY	DESCRIPTION	QUANTITY PER EQUIP.	TOTAL FOR EQUIP.	MAINTENANCE								SUPPLY		REMARKS NOTE
				R-220 LRR (continued)													
23C4A6	5960 100 7670	V111 V112 V113 V114 V301 V302 V303 V304 V310 V311 V312		ELECTRON TUBE: JAN type 6AL5	11	3	3	3			3	15	30	132	132	132	X
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23B736	5960 188 0857	V305 V306 V307 V308 V309		ELECTRON TUBE: JAN type 6J7G	5	5	5	5			5	10	18	90	90	90	X
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23B818		V101		ELECTRON TUBE: JAN type 6BA6	1	1	1	1			1	11	84	168	168	168	X
23B819		V102		ELECTRON TUBE: JAN type 6AL5	1	1	1	1			1	1	18	24	24	24	X
23B82	5960 188 7818	V103		ELECTRON TUBE: JAN type 6BE6	1	1	1	1			1	2	8	16	16	16	
23B819 A	5960 188 7967	V104		ELECTRON TUBE: JAN 1A 3A 5Y type 1B3G	1	1	1	1			1	1	1	1	1	1	X

A 23B819

SIGNAL CORPS STOCK NUMBER	FEDERAL STOCK NUMBER	REFERENCE SYMBOL	DESIGNATION BY	DESCRIPTION	QUANTITY PER EQUIP	RECOMMENDED SPARES	MAINTENANCE AUTHORIZED ALLOWANCES STOCK GUIDE ORGANIZATIONAL				FIELD				SUPPLY STOCK GUIDE DEPOT		ALLOWANCE NOTE
							TACTICAL ORGANIZATION		FIXED STATION		REPAIR SHOPS			REPAIR SHOP	ARMY TAC	BASE	
						1ST ECHELON	2ND ECHELON		2ND ECHELON		3RD ECHELON		4TH	4TH			
							1-4 EQUIP	5-20 EQUIP	EQUIP	EQUIP	1-4 EQUIP	5-20 EQUIP	50 EQUIP	100 EQUIP	50 EQUIP	1000 EQUIP	
				GROUP 1 RECEIVER GROUP													
2C4180-220				RECEIVER, RADIO R-220/URR (4 & 5 Fq reception 20 to 200 mc range) 19" lg x 14-7/8" wd x 10-1/2" hi ea													NOL
5610-308		C44o		CAPACITOR FIXED, ELECTROLYTIC 10 mfd 25V type CE35C106F ea	1	-	-	-			1	1	1	1	1	6	Y
5620-112		C85o C840		CAPACITOR FIXED, ELECTROLYTIC 20 mfd 25V type CE32C206F ea	2	-	-	-			1	1	1	2	1	20	Y
2X209-2206		Y101		CRYSTAL UNIT, QUARTZ 2206 kc nom freq, MIL type CR-18/U ea	1	1	5	5			1	1	1	2	1	12	NOL
2X209-5000		Y101		CRYSTAL UNIT, QUARTZ 5.000 kc nom freq MIL type CR-18/U ea	1	1	5	5			1	1	1	2	1	8	NOL
2X209-6886.9		Y102		CRYSTAL UNIT, QUARTZ 6.886.9 kc nom freq MIL type CR-18/U ea	1	1	5	5			1	1	1	2	1	8	NOL
2X209-7844.2		Y102		CRYSTAL UNIT, QUARTZ 7.844.2 kc nom freq MIL spec type CR-18/U ea	1	1	5	5			1	1	1	2	1	8	NOL
2X209		Y104		CRYSTAL UNIT, QUARTZ 10.486.4 kc nom freq MIL type CR-18/U ea	1	1	5	5			1	1	1	2	1	8	NOL
2X224-15.5288		Y105		CRYSTAL UNIT, QUARTZ 15.5288 mc nom freq MIL type CR 23/U ea	1	1	5	5			1	1	1	2	1	8	NOL
2X224-22.0267		Y106		CRYSTAL UNIT, QUARTZ 22.0267 mc nom freq MIL type CR-23/U ea	1	1	5	5			1	1	1	2	1	8	NOL
2X224-32.7970		Y107		CRYSTAL UNIT, QUARTZ 32.7970 mc nom freq MIL type CR-23/U ea	1	1	5	5			1	1	1	2	1	8	NOL
2X224-47.0033		Y108		CRYSTAL UNIT, QUARTZ 47.0033 mc nom freq MIL type CR-23/U ea	1	1	5	5			1	1	1	2	1	8	NOL
2JAN127		CR301		CRYSTAL UNIT, RECTIFYING MIL type JAN 1N127 ea	1		5	5			1	1	6	12	12	192	Y
2JoAko	5960-188-3531	V322 V324		ELECTRON TUBE JAN type 6AKo ea	2	1	5	5			1	3	24	48	48	180	Y

SIGNAL CORPS STOCK NUMBER	FEDERAL STOCK NUMBER	REFERENCE SYMBOL	DESIGNATION BY	DESCRIPTION	QUANTITY PER EQUIP	RUNNING SPARES	MAINTENANCE								SUPPLY		EXPENDABILITY NOTE
							AUTHORIZED ALLOWANCES				STOCK GUIDE				STOCK GUIDE		
							ORGANIZATIONAL				FIELD			DEPOT	DEPOT		
						1ST ECHELON	TACTICAL ORGANIZATION		FIXED STATION		REPAIR SHOPS			REPAIR SHOP	ARMY TAC	BASE	
							2ND ECHELON		2ND ECHELON		3RD ECHELON		4TH	5TH			
							1-4 EQUIP	5-20 EQUIP	EQUIP	EQUIP	1-4 EQUIP	5-20 EQUIP	50 EQUIP	100 EQUIP	50 EQUIP	100 EQUIP	
				R-220/URR (continued)													
3Z6925-3.42		RT301		RESISTOR, THERMAL: fil voltage regulator Amperite type 1HTF10; ea	1	2	%	%			1	2	8	14	8	72	X
3Z9823-15.72		S303A S303B		SWITCH, SENSITIVE: SPST; AC-DC sw; 25/32" lg x 1/4" wd x 23/64" h; Motorola part #240B1020; ea	2	–	–	–			1	1	2	3	2	14	X
3Z9823-15.15		S306		SWITCH, SENSITIVE: SPST; BFO on-off sw; 1-3/32" lg x 13/32" wd x 5/8" h; Micro Switch type V3-23; ea	1	–	–	–			1	1	1	2	1	8	X
3Z9695-30.3		S103		SWITCH, THERMOSTATIC: SPST; for HR101 heater; Cam-Stat type A, model A-2037; ea	1	–	–	–			1	1	1	2	1	10	X
				GROUP 2 POWER SUPPLY GROUP													
3H4497-660				POWER SUPPLY PP-660/URR: AC power supply for rec R-220/URR; ea	1	–	–	–			–	–	–	–	–	–	NX
3Z2603.2	5920-189-0846	F602		FUSE, CARTRIDGE: 3 amp; MIL type FO2G3R00A; ea	1	5	%	%			1	1	4	7	4	34	X
2J5R4WGY	5960-193-5111	V601		ELECTRON TUBE: JAN type 5R4WGY; ea	1	1	%	%			1	2	12	24	24	240	X
2Z2642.1159	5960-	H609		RETAINER, ELECTRON TUBE: Times Facsimile part #15; ea	1	–	%	%			1	1	1	1	1	4	X

THIS ADDENDA WILL REMAIN IN EFFECT ONLY UNTIL THE INFORMATION IS PUBLISHED IN AN OFFICIAL DEPARTMENT OF THE ARMY PUBLICATION.

ADDENDA NO. 2

6 JUNE 1955

ADDENDA NO. 2 TO INSTRUCTION BOOK FOR RADIO RECEIVING SET AN/URR-29 AND RADIO RECEIVER R-220/URR

The following information, published on Order No. 116–Phila–52, provides information to be added to the instruction book in addition to that provided by Addenda No. 1, 1 February 1955.

Personnel using this equipment and having custody of the addenda will enter suitable notations beside each affected paragraph and figure in the instruction book to indicate the presence of this supplementary information.

MAKE THE FOLLOWING CHANGES TO ADDENDA NO. 1.

Page 10. Fig. 125.1. Add the following note to figure 125.1:

3. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER; THE CONNECTION BETWEEN PIN 10 OF T601 AND PIN 15 OF J604 IS DELETED; PINS 12 AND 15 OF J604 ARE CONNECTED TOGETHER; R603, 1 OHM, 5 WATT, AND R604, 1 OHM, 5 WATT, ARE CONNECTED IN PARALLEL FROM PIN 10 OF T601 TO PIN 15 OF J604.

MAKE THE FOLLOWING CHANGES TO THE INSTRUCTION BOOK.

Page 57. Par. 53b. Add the following at the end of subparagraph *b*:

In units with serial numbers 93 and higher the manual gain control voltage, which is obtained from the 26 volt a-c output of the power supply, is rectified by the mgc diode (V303A), and sent to the gain control circuits of the receiver.

Page 58. Fig. 31. Add the following note to figure 31:

IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 66 AND HIGHER, CAPACITOR C266 IS .47 UUF.

Page 61. Fig. 32. Make the following changes in figure 32:

Change "S102 SECTION 2 FRONT" to read: S102 SECTION 2.

Change "S102 SECTION 2 REAR" to read: S102 SECTION 1.

Page 62. Fig. 33. Make the following changes in figure 33:

In two places, change "S102 SECTION 2 FRONT" to read: S102 SECTION 2.

In two places, change "S102 SECTION 2 REAR" to read: S102 SECTION 1.

Page 63. Fig. 34. Make the following changes in figure 34:

Change "S102 SECTION 2 FRONT" to read: S102 SECTION 2.

Change "S102 SECTION 2 REAR" to read: S102 SECTION 1.

Page 67. Fig. 38. Add the following at the end of note 2:

IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, RESISTOR R221, 470K, IS CONNECTED BETWEEN TERMINALS 2 AND 4 OF TURRET Z153 ON BAND 1.

Page 68. Par. 63. Line 3. Add the following after "R118":

In units with serial numbers 93 and higher, R118 is paralleled by R221 on band 1.

Page 71. Par. 65*d*. Line 6. Add the following after "signal":

In units with serial numbers 93 and higher, C273 is placed in parallel with C112 on bands 1 and 2 to increase the injection voltage applied to the first mixer.

Page 72. Par. 66*d*. Add the following at the end of subparagraph *d*:

In units with serial numbers 93 and higher, cathode bias resistors for V113 are switched into the circuit by S101, section 2, rear. The cathode bias resistors are as follows: band 1, R222; band 2, R223; band 3, R224; band 4, R225; band 5, R233; band 6, R222; on band 7 the cathode of V113 is grounded.

Page 72. Fig. 43. Add the following note to figure 43:

3. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, THE FOLLOWING CATHODE BIAS RESISTORS ARE USED:

BAND	RESISTOR	VALUE (OHMS)
1	R222	150
2	R223	100
3	R224	270
4	R225	220
5	R223	100
6	R222	150
7	NONE	0

Page 73. Par. 67*b*(1). Add the following at the end of subparagraph (1):

In units with serial numbers 93 and higher, C274 is placed in parallel with C174 on bands 1 and 2 to increase the injection voltage applied to the second mixer.

Page 76. Fig. 47. Add the following note to figure 47:

IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, C303 IS 3.9 UUF; C308 AND THE CONNECTION TO MGC DIODE V303A ARE DELETED.

Page 77. Par. 68*g*. Add the following at the end of subparagraph *g*:

In units with serial numbers 93 and higher, voltage for manual gain control is obtained from the 26 volt a-c output of the power supply and applied to the mgc diode V303A.

Page 77. Fig. 48. Add the following note to figure 48:

3. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 23 AND HIGHER, A CONTACT IS ADDED AT TERMINAL 11 OF S301 SECTION 1 REAR AND TERMINALS 10 AND 11 ARE CONNECTED TOGETHER.

Page 80. Par. 69*b*. Add the following at the end of subparagraph *b*:

In units with serial numbers 23 and higher, when the 200-kc filter FL304 is switched into the circuit, R436 is placed in parallel with R311 through section 1, rear of S301, decreasing the output of mgc diode V303A. In this manner the gain of the receiver is increased to compensate for the insertion loss of FL304.

Page 92. Fig. 62. Add the following note to figure 62:

IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 66 AND HIGHER, R433 IS 2.7 MEG AND R434 IS 470K.

Page 93. Fig. 63. Add the following note to figure 63:

IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 66 AND HIGHER, R433 IS 2.7 MEG AND R434 IS 470K.

Page 96. Fig. 67. Add the following note to figure 67:

4. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, TERMINALS 4 AND 5 OF T301 AND TERMINALS 4 AND 5 OF T302 ARE CONNECTED INTERNALLY; THE LEAD FROM TERMINAL 4 OF T301 TO TERMINAL 4 OF TB308 IS REMOVED; A JUMPER IS CONNECTED BETWEEN TERMINALS 3 AND 4 OF TB308.

Page 98. Fig. 68. Add the following note to figure 68:

4. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 66 AND HIGHER, R433 IS 2.7 MEG.

Page 99. Par. 78b. Line 5. Add the following after the second sentence:

In units with serial numbers 93 and higher, 26 volts a-c is applied to the manual gain control rectifier V303A from the output of the power supply.

Page 100. Fig. 69. Add the following notes to figure 69:

5. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 23 AND HIGHER, A CONTACT IS ADDED AT TERMINAL 11 OF S301 SECTION 1 REAR AND TERMINALS 10 AND 11 ARE CONNECTED TOGETHER.
6. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 66 AND HIGHER, R433 IS 2.7 MEG AND R434 IS 470K.
7. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, THE FOLLOWING DIFFERENCES EXIST:
   C310 IS .1 UF
   C311 IS 10 UF
   R309 IS 120K
   C308 AND R306 ARE DELETED
   26 VOLTS A-C IS CONNECTED TO THE CATHODE, PIN 1, OF V303A.

Page 100. Par. 79b. Line 6. Add the following after the word "receiver": and voltage for the mgc rectifier V303A.

Page 101. Par. 80a(1). Add the following at the end of subparagraph (1):

In units with serial numbers 93 and higher, all points of equal potential in the filament circuit are bonded together to insure an even voltage distribution.

Page 103. Fig. 70. Add the following notes to figure 70:

4. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 23 AND HIGHER, A CONTACT IS ADDED AT TERMINAL 11; TERMINALS 10 AND 11 OF S301, SECTION 1 REAR, ARE CONNECTED TOGETHER.
5. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER THE FOLLOWING DIFFERENCES EXIST:
   C310 IS .1 UF
   C311 IS 10 UF
   R309 IS 120K
   C308 AND R306 ARE DELETED
   26 VOLTS A-C IS CONNECTED TO THE CATHODE, PIN 1, OF V303A.

Page 105. Fig. 72. Add the following note to figure 72:

4. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, TERMINALS 4 AND 5 OF T301 ARE CONNECTED INTERNALLY; THE LEAD FROM TERMINAL 4 OF T301 TO TERMINAL 4 OF TB308 IS REMOVED; A JUMPER IS CONNECTED BETWEEN TERMINALS 3 AND 4 OF TB308.

Page 120. Fig. 80. Add the following note to figure 80:

IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, R439 AND R440 ARE DELETED.

Page 121. Fig. 81. Add the following note to figure 81:

IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, R437 IS DELETED.

Page 121. Fig. 82. Add the following note to figure 82:

IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, R441 AND R442 ARE DELETED.

Page 122. Fig. 84. Add the following note to figure 84:

IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, R438 IS DELETED.

Page 134. Fig. 97. Add the following note to figure 97:

IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER; R222, R223, R224, AND R225 HAVE BEEN ADDED AT S101, SECTION 2; C274 HAS BEEN ADDED AT S101, SECTION 4.

Page 177. Par. 121b. Delete subparagraph *b* and substitute the following:

b. F-m Sensitivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Set the BAND SELECTOR to band 1 and tune to 21 mc. Rotate the SELECTIVITY switch to 200 K.C., AUDIO RESPONSE switch to MEDIUM, and the OPERATION switch to FM SQUELCH. Set the R.F. GAIN-SQUELCH control to maximum.

(2) *Meter connections.* Connect Output Meter TS-585/U to pins 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator SG-3/U to the receiver antenna input through adapter E101 and the dummy antenna.

(3) *Tests.* Adjust the signal generator for an output of 3 uv unmodulated at 21 mc. Adjust the TUNING control for maximum quieting of the receiver. Decrease signal generator output to zero. Adjust AUDIO GAIN 1 and AUDIO GAIN 2 controls for 10 db (10 mw) noise output. Increase signal generator output until 20 db of quieting is obtained (.1 mw). The output of the signal generator should not exceed 3 uv. Using this procedure check the sensitivity of the receiver at the frequencies listed in the following chart.

Band	Receiver and generator frequency (mc)	Receiver input (uv)
1	21	3
1	24	3
1	28	3
2	30	3
2	34	3
2	40	3
3	42	3
3	49	3
3	56	3
4	60	3
4	70	3
4	80	3
5	84	3
5	100	3
5	112	3
6	120	3
6	142	3
6	160	3
7	168	7.2
7	200	7.2
7	230	7.2

Page 189. Fig. 122. Add the following note to figure 122:

IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, THE INPUT TO THE MGC DIODE V303A IS FROM THE 26 VOLT A-C OUTPUT OF THE POWER SUPPLY INSTEAD OF THE 2205-KC OSCILLATOR V302.

Page 193. Fig. 124. Add the following note to figure 124:

6. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, 26 VOLTS A-C IS SUPPLIED TO MGC DIODE V303A.

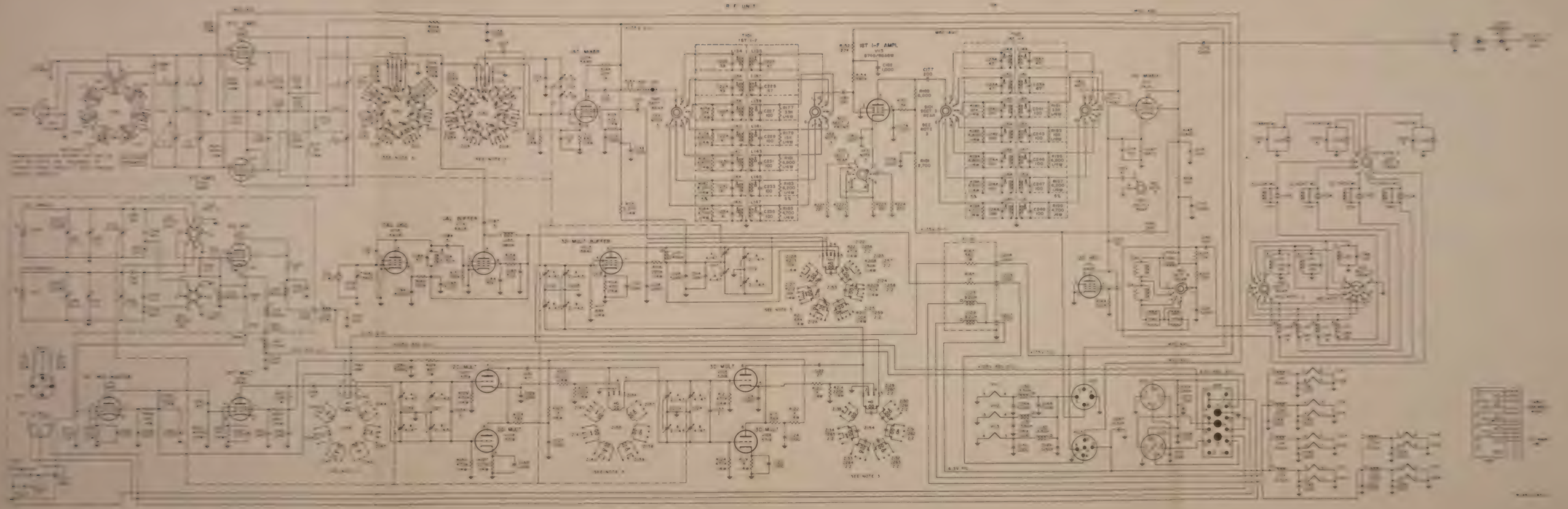
Page 199. Fig. 127. Add the following note to figure 127:

4. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, R221, 470K, IS CONNECTED IN PARALLEL WITH R118 ON BAND 1.

Page 201. Fig. 128. Add the following note to figure 128:

4. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, R437, R438, R439, R440, AND R441 ARE NOT USED; ALL POINTS OF EQUAL POTENTIAL IN THE MAIN UNIT FILAMENT STRING ARE BONDED TOGETHER.

Page 211. Fig. 132. Add figure 132.1 after figure 132.


R.F. UNIT
1ST I-F AMPL
VR13
6AG7/6AK5W
1ST MIXER
VR12
6BE6
1ST OSC
VR11
6BE6
R.F. AMPLIFIER
VR10
6BA6
R.F. AMPLIFIER
VR9
6BA6
2ND MIXER
VR14
6BE6
2ND OSC
VR15
6BE6
2ND I-F AMPL
VR16
6BA6
2ND I-F AMPL
VR17
6BA6
2ND DET. AVC & A.F. AMPL
VR18
6AV6
A.F. AMPL
VR19
6AV6
A.F. OUTPUT
VR20
6V6GT
A.F. OUTPUT
VR21
6V6GT
RECTIFIER
VR22
5Y3GT
RECTIFIER
VR23
5Y3GT
SEE NOTE 1
SEE NOTE 2
SEE NOTE 3
SEE NOTE 4
SEE NOTE 5
SEE NOTE 6
SEE NOTE 7
SEE NOTE 8
SEE NOTE 9
SEE NOTE 10
SEE NOTE 11
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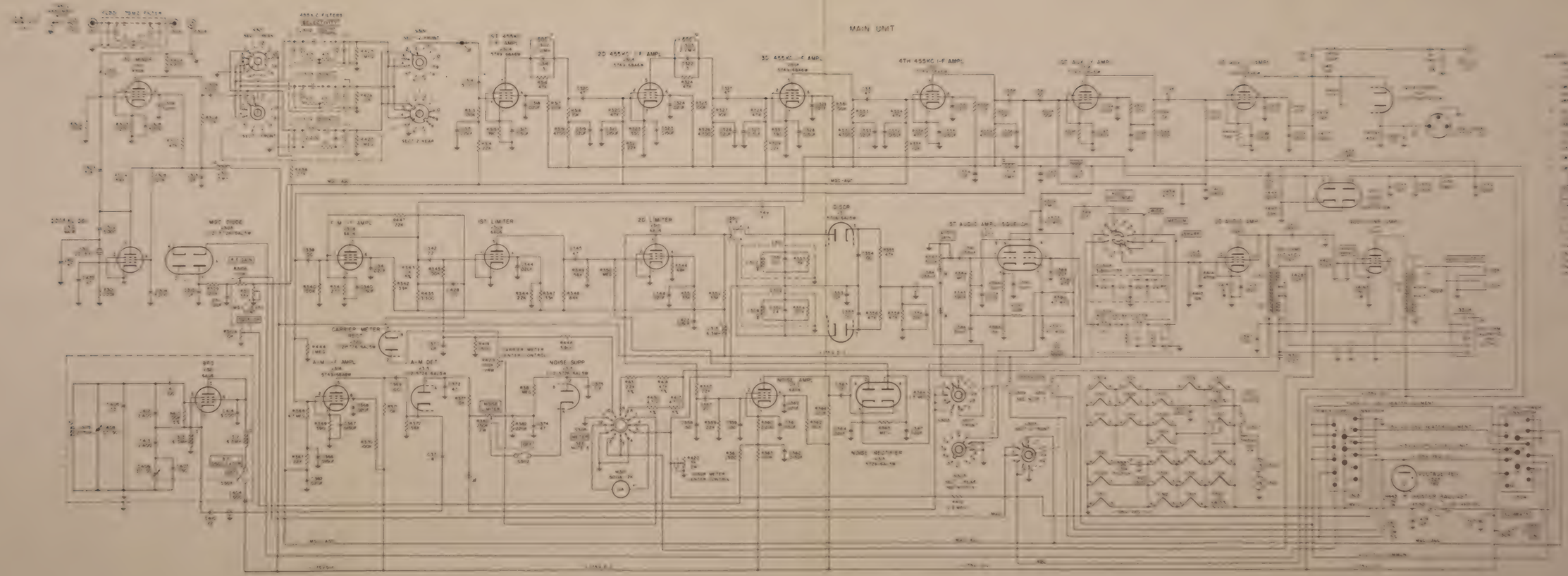

MAIN UNIT
1ST AUDIO AMPL.
2D AUDIO AMPL.
1ST LIMITER
2D LIMITER
DISCR.
NOISE AMPL.
NOISE RECTIFIER
NOISE SUPP.
CARRIER METER
A-M DET.
A-M I-F AMPL.
F-M I-F AMPL.

INSTITUTE

THIS ADDENDA WILL REMAIN IN EFFECT ONLY UNTIL THE INFORMATION IS PUBLISHED IN AN OFFICIAL DEPARTMENT OF THE ARMY PUBLICATION.

ADDENDA NO. 1

1 FEBRUARY 1955

ADDENDA NO. 1 TO
INSTRUCTION BOOK
FOR
RADIO RECEIVING SET AN/URR-29
AND
RADIO RECEIVER R-220/URR

The following information, published on Order No. 116-Phila-52, provides information to be added to the instruction book.

Personnel using this equipment and having custody of this addenda will enter suitable notations beside each affected paragraph and figure in the instruction book to indicate the presence of this supplementary information.

Change "cord CD-307-A" to read: Headset Extension Cord CCN-49534A, wherever it appears in the instruction book.

Change "headset Navy type CW-49507" to read: Headset Assembly Navy Type CCN-49507B, wherever it appears in the instruction book.

Page 1. Par. 3a. Line 9. Delete the following: "headset Cord CD-307-A".

Page 3. Par. 4. Line 4. Change the receiver sensitivity to read as follows:

A-m signals.....2.5 uv (microvolts) or better on bands 1 through 5.
4 uv or better on band 6.
6.5 uv or better on band 7.

C-w signals.....1.2 uv or better on bands 1 through 5.
1.7 uv or better on band 6.
2.2 uv or better on band 7.

F-m signals.....6.5 uv or better on bands 1 through 5.
7.5 uv or better on band 6.
16 uv or better on band 7.

Page 4. Par. 5b. Line 5. Change "headset Navy type CW-49507" to read: Headset Assembly Navy Type CCN-49507B with Headset Extension Cord CCN-49534A.

Line 7. Delete the following: "headset Cord CD-307-A".

Right-hand column. Line 3. Delete the following: "headset Cord CD-307-A".

Page 4. Par. 5c. Line 7. Change "headset Cord CD-307-A, headset Navy type CW-49507" to read: Headset Assembly Navy Type CCN-49507B with Headset Extension Cord CCN-49534A.

Line 18: Delete the following: "headset Cord CD-307-A".

Page 5. Par. 5. Make the following changes in paragraph 5: In subparagraph *e*(1), in the "Contents" column, line 1, change "headset Navy type CW-49507" to read: Headset Assembly Navy Type CCN-49507B with Headset Extension Cord CCN-49534A.

In subparagraph *e*(2), in the "Contents" column, line 2, change "Headset Navy type CW-49507, headset Cord CD-307-A" to read: Headset Assembly Navy Type CCN-49507B with Headset Extension Cord CCN-49534A. In subparagraph *e*(3), in the "Contents" column, line 1, delete the following: "headset Cord CD-307-A,".

In subparagraph *e*(4), in the "Contents" column, line 2, delete the following: "Headset Cord CD-307-A,".

Page 6. Par. 6. In the "Component" column, change line 9 to read as follows: Headset Assembly Navy Type CCN-49507B.

Page 6. Par. 8b. Line 11. Change "knurled thumbscrews" to read: screws.

Page 8. Par. 9c. Add the following after the last sentence: When Radio Receiver R-220/URR is shipped in Receiver Case CY-956/URR, the antenna adapter E101 is fastened to the rear of the front cover. When the case is not supplied with the receiver, the antenna adapter is fastened to the rear apron of the receiver.

Page 9. Par. 9f. In the "Function" column of the table, item V303, change "(A) Mgc diode. (B) Not used" to read: Mgc diode.

Right-hand column. In the "Function" column of the table, item V320, change "(B) Not used" to read as follows: (B) Not used in unit with serial number 1. Carrier meter rectifier in units with serial numbers 2 and higher.

Page 10. Par. 10. Line 8. Delete "or to the antenna adapter".
Lines 9 through 14. Delete "When using an *** CG-718/U".

Page 12. Par. 11d. Change the last sentence to read as follows: The cord, which is packaged with Headset Assembly Navy Type CCN-49507B, is 5 feet, 7 inches long.

Page 12. Par. 13. In the second item of the "Item" column, change "1 amp" to read: .1 amp.

Page 13. Par. 13. In the table, line 4 of the second column, change "4" to read: 3.

Page 21. Par. 17c. Fourth line from bottom. Delete "and to the antenna adapter".

Page 26. Par. 18b. Add the following at the end of the subparagraph: Inspect the antenna adapter mounted on the cover of the case.

Page 26. Par. 18f. Delete the last sentence.

Page 32. Par. 22a. In the "Function" column, change item 6 to read as follows: 6. FM SQUELCH. Permits f-m reception in conjunction with squelch.

Page 47. Par. 45b(4). In the chart, change the resistance reading for Pin No. 10 to read as follows: 368K (band 1), 508K (band 2), inf. (bands 3 through 7).

Page 48. Par. 45b(5). In the chart, change the resistance reading for Pin No. B to read as follows: 368K (band 1), 508K (band 2), inf. (bands 3 through 7).

Page 53. Par. 47. Change the note at end of the chart to read as follows: [a] Normal readings depend upon the individual receiver. In the CARRIER position reverse meter readings are a normal indication on unit bearing serial number 1 only when no signal is being received. The db calibration on the CARR. db scale of the meter is for reference only. Record the readings for future reference.

Page 58. Fig. 31. Change the value of R108 from 10K to 4,700 ohms.

Page 60. Par. 59d. Line 14. Delete the following: "C251 across Z107,".
Change the next to the last sentence to read as follows: Variable capacitors across the links on Z101 through Z106, and across the secondary winding on Z107, are used to balance the input circuit.

Page 60. Par. 59e. Add the following at the end of the subparagraph: On bands 1 and 2 resistors R219 and R220, on coil assemblies Z108 and Z109 respectively, are switched into the B+ circuit of V101 and V102 to improve screen grid voltage regulation.

Page 63. Par. 60e. Line 5. Change "A" to read: B.
Line 7. Change "B" to read: A.

Page 63. Fig. 34. Change the value of C269 from 1,500 uuf to .1UF.

Page 64. Fig. 35. Change the value of C269 from 1,500 uuf to .1UF.

Page 67. Fig. 37. Add a ground connection to the junction of capacitors C121A and C121B.

Page 71. Fig. 42. Change the value of C112 from 33 uuf to 10 uuf.

Page 72. Fig. 43. Change the value of R153 from 470 ohms to 270 ohms.

Page 73. Fig. 44. Change the value of C174 from 120 uuf to 100 uuf.

Page 76. Fig. 47. Make the following changes in figure 47: Change "TO PIN 1 ON V303A, MGC DIODE" to read: TO PINS 1 AND 2 ON V303, MGC DIODE.

Add the following note to figure 47:

IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 2 AND HIGHER, RESISTOR R303 IS 2,200 OHMS.

Page 77. Fig. 48. Change the value of R436 from 39K to 27K.

Page 80. Par. 69b. Add the following at the end of the subparagraph: When the 10 kc filter FL302 is switched into the circuit, R436 is placed in parallel with R311, through section 1, rear, of S301, decreasing the output of mgc diode V303. In this manner the gain of the receiver is increased to compensate for the greater insertion loss of filter FL302.

Page 80. Par. 70. Line 11. Change "R368" to read: R444.
Line 12. Change "R367 and C366" to read: R367, R368, and C366.

Page 81. Fig. 51. Make the following changes in figure 51:

Change the value of R368 from 47K to 4.7 MEG.

Add resistor R444, 1 MEG, from pin 1 of V314 to ground.

Page 83. Fig. 53. Change the value of C410 from 8 uuf to 22 uuf.

Page 84. Fig. 54. Make the following changes in figure 54:

Change the values of components as follows:

Component	Change From	To
R342	100K	39K
R343	10K	11K
R345	10K	100K
R419	150 ohms	1,500 ohms
R435	4,700 ohms	3,300 ohms
C342	200 uuf	22 uuf
R429	25K	100K

Delete resistor R432, 18K.

Add resistor R448, 3,900 ohms, from the junction of R345 and R419 to pin 10 of METER switch S305.

Add the following notes to figure 54.

3. ON ORDER NO. 116-PHILA-52 FOR RADIO RECEIVER R-220/URR WITH SERIAL NUMBER 1 ONLY, RESISTOR R447, 22K, IS ADDED BETWEEN CR303 AND R429.
4. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 2 AND HIGHER, MAKE THE FOLLOWING CHANGES: DELETE CR302, 1N127, AND ADD RESISTOR R447, 22K, IN ITS PLACE. DELETE CR303, 1N127, AND ADD A DIODE SYMBOL IN ITS PLACE. LABEL THE DIODE, CARRIER METER RECTIFIER V320B, (½) 5726/-6AL5W. LABEL THE PLATE OF THE DIODE PIN 2 AND CONNECT IT TO THE TOP OF R429. LABEL THE CATHODE PIN 5 AND CONNECT IT TO THE JUNCTION OF C428 AND R447. CHANGE THE VALUE OF C345 FROM 100 UUF TO 47 UUF. CHANGE THE VALUE OF R349 FROM 220K TO 56K.

Page 85. Par. 73*a*(1). Line 1. Change "through R432 and C376" to read: through C376.

Page 85. Par. 73*a*(2). Add the following after subparagraph (2):

(3) In unit with serial number 1, the signal developed across plate load resistor R435 is fed through C428 to crystal diode CR303. CR303 functions as a half-wave rectifier. The rectified voltage is applied through R447 to carrier meter center control R429. In units with serial numbers 2 and higher, the signal developed across plate load resistor R435 is fed through C428 to carrier meter rectifier V320B. The rectified voltage is developed across carrier meter center control R429. The movable arm of R429 is connected to meter M301 when the METER switch is in the CARRIER position. In unit with serial number 1, crystal diode CR302 supplies a bucking voltage to meter M301 to prevent a meter reading, due to noise voltage, when no signal is being received. In units with serial numbers 2 and higher, the bucking voltage is supplied to carrier meter rectifier V320B through resistor R447.

Page 85. Par. 73*b*(4). Line 4. Change line 4 to read as follows: through current limiting resistor R448 and METER switch S305 in the.

Page 86. Par. 73*b*(5). Line 4. Change line 4 to read as follows: the plate of V308 through R435 and R443, and.

Page 92. Par. 75*b*. Delete the third sentence of subparagraph *b*.

Page 93. Fig. 63. At the junction of R404 and pin 7 of V319, delete the arrow and the words: "TO PIN 5 ON V316, AGC DIODE".

Page 93. Par. 75*c*. Change the second sentence to read as follows: The other half of the tube is not used in unit with serial number 1; in units with serial numbers 2 and higher, the other half of the tube (V320B) is the carrier meter rectifier.

Page 98. Fig. 68. Make the following changes in figure 68:

Change the value of R368 from 47K to 4.7 MEG.

Add resistor R444, 1 MEG, from pin 1 of V314 to ground.

Add capacitor C272, .1UF, from pin E of J103 to ground. Ground pin 6 of OPERATION switch S303, section 2, front, and delete the words: "FIXED MGC".

Page 99. Par. 78*a*. Line 7. Change "V303A" to read: V303.

Delete the last two sentences of subparagraph *a* and substitute the following: Both V303 and V316 are twin diodes which function as voltage doublers.

Page 99. Par. 78*b*. Change the first sentence of subparagraph *b* to read as follows: Manual gain control voltage is developed in the 2205-kc oscillator and capacitively coupled through C308 to the cathode, pin 1, and the plate, pin

2, of the manual gain control rectifier, V303. Add the following after the first sentence of subparagraph *b*: On the positive half-cycle of the input signal V303B conducts, charging C308 negative on the plate side. This voltage adds to the peak value of the following (negative) half-cycle applied to C303A and the circuit functions as a half-wave voltage doubler.

Page 99. Par. 78c(1). Line 8. Delete the following: "R432 and".
Line 14. Delete the following: "R429, and R377,".

Page 99. Par. 78c(3). Change the first sentence of subparagraph (3) to read as follows: A positive voltage from the junction of voltage divider resistors R445 and R446 is fed to the cathode, pin 5, of V316A, to render V316A inoperative at low signal levels.
Line 6. Change "R404" to read: R445.
Line 7. Delete the following: "R429, and R377,".

Page 100. Fig. 69. Make the following changes in figure 69:

Change the value of R309 from 22K to 56K.

Change the value of R436 from 39K to 27K.

Change the value of R378 from 120K to 680K.

Delete R432, 18K.

Delete C399, .015UF.

Change R404, 560 to read: R445, 39K.

Change "FROM PIN 7 ON V319, 2D AUX I-F AMPL" to read: +175 V.

Add resistor R446, 220K, from +175 V to the junction of R445 and pin 5 of V316.

Add a diode symbol to the left of V303A; connect the plate, pin 2, to the cathode, pin 1 of V303A; connect the cathode, pin 5, to ground. Label the diode V303B.

Delete the connection from the junction of R311 and R436 to pin 6 of OPERATION switch S303, section 2, front. Ground pin 6 of OPERATION switch S303, section 2, front.

Page 100. Par. 78d. Delete subparagraph *d*.

Page 100. Par. 79a. Delete the third sentence and substitute the following: Filter network FL601, composed of coils L603 and L604 and capacitors C611 through C616, and capacitors C606 and C607 filter out any r-f voltage that may be present on the a-c line.

Page 101. Par. 79b. Line 3. Change line 3 to read as follows: center tap is grounded through R602 and terminals 7 and 5.

Line 6. Add the following sentence after the word "cycles". Resistor R602 limits the peak current drawn by V601.

Page 101. Par. 79d. Add the following after the first sentence: Capacitor C426 serves as a B+ line bypass capacitor.

Page 101. Par. 80a(1). Right-hand column. Line 5. Add the following after the word "filaments": due to voltage dropping resistors R438, R439, R440, and R441.

Line 14. Add the following after "R421": , R437, R442,.

Page 102. Par. 82b(1). Delete the first sentence of subparagraph (1) and substitute the following: In unit with serial number 1, the d-c output from the crystal diode CR303 is applied to the carrier meter center control R429, where it is negative with respect to ground. In units with serial numbers 2 and higher, the d-c output from carrier meter rectifier V320B is applied to the carrier meter center control R429, where it is negative with respect to ground.

Page 103. Fig. 70. Make the following changes in figure 70:

Change the value of R378 from 120 to 680K.

Change the value of R436 from 39K to 27K.

Change the value of R309 from 22K to 56K.

Delete resistor R432, 18K.

Delete the connection from the junction of R436 and R311 to pin 6 of OPERATION switch S303, section 2, front. Ground pin 6 of OPERATION switch S303, section 2, front.

Add the following note to figure 70:

4. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 15 AND HIGHER, RESISTOR R443 IS 560 OHMS.

Page 104. Par. 82b(1). Add the following at the end of subparagraph (1): When no signal is being received a bucking voltage is supplied to the meter, causing the meter needle to be deflected to the left. In this manner the meter will not respond to noise voltages. When a signal is received the bucking voltage is overcome and the meter reads upscale.

Page 104. Par. 82b(4). Change the second sentence of subparagraph *b*(4) to read as follows: It is then fed through R448 and S305 to meter M301 and returns through ground to V309.

Page 105. Fig. 72. Make the following changes in figure 72:

Change the values of components as follows:

Component	Change from	To
R429	25K	100K
R343	10K	11K
R435	4,700 ohms	3,300 ohms
R345	10K	100K
R419	150 ohms	1,500 ohms

Add resistor R448, 3,900 ohms, from the junction of R345 and R419 to pin 10 of METER switch S305.

Add the following notes to figure 72:

4. ON ORDER NO. 116-PHILA-52 FOR RADIO RECEIVER R-220/URR WITH SERIAL NUMBER 1 ONLY, RESISTOR R447, 22K, IS ADDED BETWEEN CR303 AND R429.
5. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 2 AND HIGHER, MAKE THE FOLLOWING CHANGES: DELETE CR302, 1N127, AND ADD RESISTOR R447, 22K, IN ITS PLACE. DELETE CR303, 1N127, AND ADD A DIODE SYMBOL IN ITS PLACE. LABEL THE DIODE, CARRIER METER RECTIFIER, V320B, (½) 5726/-6AL5W. LABEL THE PLATE OF THE DIODE PIN 2 AND CONNECT IT TO THE TOP OF R429. LABEL THE CATHODE PIN 5 AND CONNECT IT TO THE JUNCTION OF C428 AND R447.

Page 113. Par. 94c. In the "Probable trouble" column, change item 8 to read as follows: 8. Defective f-m i-f amplifier V308 or crystal diode CR303 (unit with serial number 1) or carrier meter rectifier (units with serial numbers 2 and higher).

In the "Correction" column, change item 8 to read as follows: 8. Check voltage and resistance measurements at V308 socket.

Page 120. Fig. 80. Delete R432 and the call-out.

Page 124. Fig. 86. Make the following changes in figure 86.

On the left-hand side of R309, change "†157K" to read: †173K.

At pin 2 of V303, change "OV, ∞" to read: 9V, 100K.

At pin 5 of V303, change "∞" to read: 0.

At pin 7 of V303, change "157K†" to read: 173K†.

Change note 3 to read as follows:

3. ALL MEASUREMENTS MADE WITH THE FOLLOWING CONTROL SETTINGS:

Control	Setting
OPERATION	MGC
R.F. GAIN SQUELCH	MID-POSITION
B.F. OSCILLATOR	MID-POSITION
SELECTIVITY	50 KC

Page 125. Fig. 87. Make the following changes in figure 87:

At pin 5 of V316, change "560" to read: 39K.

At pin 7 of V316, change "120K" to read: 680K.

On right-hand side of R342, change "120K" to read: 59K.

At pin 1 of V309, change "10K" to read: 101K.

At pin 6 of V308, change "120K" to read: 59K.

Delete R432 and its measurements.

Page 144. Par. 100. Add the following after subparagraph *a*:

Caution: Disassembly of the control head should be limited to those parts which are maintenance items (subparagraph *h*).

Page 146. Par. 100c. Delete the next to the last sentence.

Page 147. Par. 100d. Delete the last sentence.

Page 147. Par. 100e. Third line from bottom.

Change "O through X" to read: O, P, R, and X.

Delete the last sentence.

Page 147. Par. 100e(3). Delete subparagraph (3) and substitute the following:

(3) *Assembly R.* Loosen two setscrews R3 and remove i-f spur gear R1 and bevel gear R2 from oscillator switch drive shaft W2.

Page 147. Par. 100e(4) and (5). Delete subparagraphs (4) and (5).

Page 148. Par. 100e(6) and (7). Delete subparagraphs (6) and (7).

Page 148. Par. 100e(8). Delete subparagraph (8) and substitute the following:

(8) *Assembly W.* With assembly R removed, oscillator switch drive shaft W2, with oscillator switch shaft coupler W3 attached, can be removed from control bearing frame #3 (CC1).

Page 148. Par. 100e(9). Change the second sentence to read as follows: Remove i-f switch gear shaft X4, i-f switch coupler arm X7, and rollpin X8.

Page 153. Par. 100g. Add subparagraph *h* after subparagraph *g*.

h. Control Head Maintenance Items.

Parts	Ref Symbol	Manufacturers Part No.	Signal Corps Stock No.
Control Head	O164	201E1510	2C4180-220-11
A1 through A6	O171	244B1021	2C4180-220-17
A7	H193	241B1033	2Z8878-499
B1 through B4	O169	244B1020	2C4180-220-15
B5	O211	247B1149	2Z8203-951
C1, C2, C4, C5, C6	O221	244B1061	
C6	H236	241B1047	
D1	O214	243A1110	2Z5180-67
D2	H215	234A1006	2Z3723-582
D4	O222	247A1131	
DD1	H209 through H212	247A1163	6L31151-46
DD2	H197 through H200	243A1056	
DD3	H205 through H208	243A1111	
DD4	H201 through H204	243K1178	
E1	O213	243A1058	2Z5180-70
E2	H214	234A1010	2Z3723-580
F1	H213	234K1007	2Z3723-581
F2	O167	243B1087	2Z5180-68
G	O168	244B1010	2Z4878C-63

Parts	Ref Symbol	Manufacturers Part No.	Signal Corps Stock No.
H1, H2, H3, H4, H7, H8 & H9	O166	244B1063	2C4180-220-12
H9		241B1046	
J1 through J3	O172	247B1100	2C4180-220-8
K1 through K7	O173	244C1040	2C4180-220-5
K6	H194	241B1105	2Z8878-502
K7	H192	242B1147	2Z7858-70
L1, L2	O320	243B1250	2Z2935-340
L4	O307	264A1221	
L5	O306	264A1231	
L6	H235	246B1152	
M2	O180	244B1043	2Z4878C-58
N2	O181	244B1048	2Z4878C-57
O1 through O3	O179	247B1153	2Z4878C-59
P1 through P3	O178	244B1050	2Z4878C-60
R1 through R3	O220	244C1060	
W2 through W4	O199	247B3543	
X1	O198	244B1002	2Z4877-96
X4, X7 & X8	O196	247B1093	2Z3273-362
X5	H196	204B1043	6L58026-114
CC, S, T, U1, U2, U4, U5, V, W, X	O186	207D1258	2C4180-220-19

Page 158. Fig. 112. Delete figure 112 and insert new figure 112.

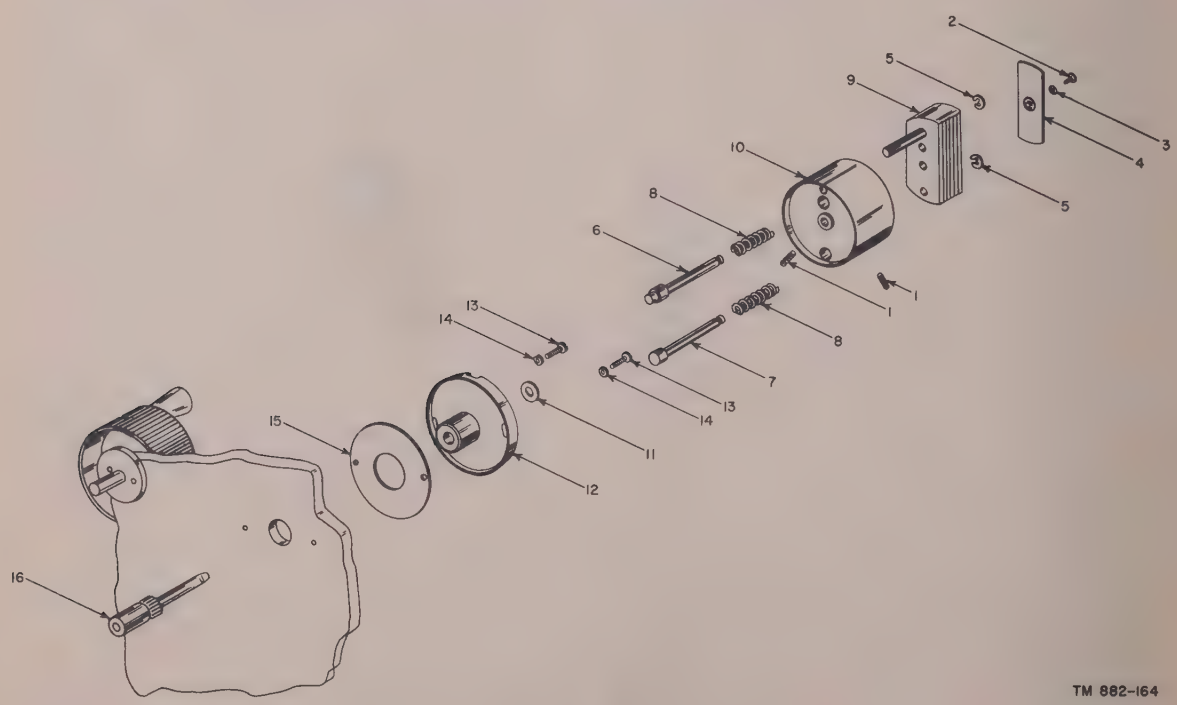


Figure 112. BAND SELECTOR knob, exploded view.

Pages 158 and 159. Par. 102c and d. Delete subparagraphs *c* and *d* and insert new subparagraphs *c* and *d*.

c. Disassembly of BAND SELECTOR Knob. Figure 112 shows an exploded view of the BAND SELECTOR control knob. Reference numbers are assigned to parts on the illustration as an aid in disassembly. A cross-reference chart in subparagraph *d* lists the reference number, name, and manufacturers part number of parts shown in figure 112. To disassemble the control knob, proceed as follows:

(1) Loosen setscrews 1 from main knob 10. Do not remove the setscrews from the knob.

(2) Remove the band switch knob, consisting of items 2 through 10, from band switch sleeve and pinion assembly 16.

(3) Remove machine screw 2 and lockwasher 3 and lift cover plate 4 off knob turn assembly 9.

(4) Push in detent pin 6 from rear until retaining ring 5 is accessible. Remove retaining ring.

(5) Push in guide pin 7 from rear until retaining ring 5 is accessible. Remove retaining ring.

(6) Remove knob turn assembly 9 from main knob 10.

(7) Remove detent pin 6, guide pin 7, and springs 8 from main knob.

(8) Remove detent plate 12 and gasket 15 by removing machine screws 13 and washers 14.

(9) Reassemble by reversing the above procedure. When replacing cover plate 4 place lettered side over detent pin.

d. Cross-reference Chart.

Ref No.	Name	Manufacturers Part No.
1	Setscrew 8-32 x 3/16 Allen head)	3S116674
2	Machine screw (3-48 x 1/4)	3S123419
3	Lockwasher	4S9767
4	Cover plate	264B3695
5	Retaining ring	242K3552
6	Detent pin	222B3689
7	Guide pin	222B3691
8	Spring	241B3701
9	Knob turn assembly	236B3686
10	Main knob	236B3698
11	Washer	4S123425
12	Detent plate	264C3687
13	Machine screw (6-32 x 3/8)	3S114790
14	Washer	4S116708
15	Rubber gasket	232B3700
16	Band switch sleeve and pinion assembly	244B1023

Page 165. Par. 109b. Line 5. Change ".5" to read: .4.

Page 168. Par. 112e. Last line. Change ".05 volt" to read: .3 volt.

Page 169. Par. 114d. Delete the last sentence of subparagraph *d* and substitute the following: With the R.F. GAIN-SQUELCH control set at maximum and AUDIO GAIN 1 and AUDIO GAIN 2 controls set at mid-position, the meter should indicate grid current. Increasing the output of the signal generator should increase the current reading on the meter.

Page 170. Par. 115. Add the following paragraph after paragraph 115.

115.1. Mgc Level Control Adjustment

a. Receiver Controls. Set the receiver front panel controls to the following positions:

(1) BAND SELECTOR to band 7.
(2) TUNING to 230 mc.
(3) B.F. OSCILLATOR to OFF.
(4) SELECTIVITY to 200 KC.
(5) AUDIO RESPONSE to MEDIUM.
(6) R.F. GAIN-SQUELCH to maximum.
(7) NOISE LIMITER to OFF.
(8) OPERATION to MGC.
(9) AUDIO GAIN 1 to two-thirds maximum.
(10) AUDIO GAIN 2 to maximum.
(11) CALIBRATE to OFF.

b. Meter Connections. Connect Output Meter TS-585/U to terminals 1 and 2 of TB308. Set input impedance to 600 ohms. Connect Signal Generator TS-497/URR, externally modulated by Audio Oscillator TS-382A/U, to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for a 10 uv output at 230 mc, amplitude modulated 30 percent at 400 cycles by the external audio oscillator.

c. Tests. Adjust ANTENNA TRIMMER and AUDIO GAIN 1 controls for maximum output as indicated on the meter. Loosen the locknut on R311 located on the right-hand side of the receiver. Adjust R311 for maximum output without overloading. Tighten locknut on R311. Decrease generator output to minimum. Slowly increase the generator output to 10 uv. The output, as indicated on the output meter, should be approximately linear over the input range and show no sign of limiting.

Page 170. Par. 118a(1). Add the following at the end of subparagraph (1): Set the OPERATION switch to AGC.

Page 170. Par. 118a(2). Change the last sentence to read as follows: Adjust the signal generator for a level sufficient to produce a signal-plus-noise to noise ratio of 40 db (approximately 500 uv) at 30 mc, amplitude modulated 30 percent at 1,000 cycles by the external audio oscillator.

Page 171. Par. 118a(3)(d). Add the following after the first sentence: Adjust R.F. GAIN-SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for an output of 20 db as indicated on the output meter.

Page 171. Par. 118a(3)(e). Add the following after the first sentence: Adjust the R.F. GAIN-SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for an output of 20 db as indicated on the output meter.
Line 7. Change "0 db" to read: 20 db.

Page 172. Par. 118c(1). Add the following after the last sentence: Set the OPERATION switch to AGC.

Page 173. Par. 118d(3)(b). Add the following at the end of the subparagraph: *Note.* The distortion measurement of 4 percent is for harmonic distortion in the receiver only. Any distortion introduced by the test equipment must be added to this figure.

Page 173. Par. 118e(1). Last line. Change "maximum" to read: mid-position.

Page 173. Par. 118e(2). Change the last sentence to read as follows: Adjust the signal generator for an output of 1,000 uv at 30 mc, amplitude modulated 30 percent at 400 cycles.

Page 173. Par. 118e(3). Delete the first sentence and substitute the following: Adjust the ANTENNA TRIMMER for maximum; adjust AUDIO GAIN 1 and AUDIO GAIN 2 controls for an output of 500 mw. Remove modulation from signal generator.
Last sentence: Change "50 db" to read: 40 db.

Page 173. Par. 119a(3)(b). Make the following changes in the table: In the "Test frequency (mc)" column, change "69" to read: 75; "98" to read: 106 ;and "140" to read: 150. In the "Image frequency (mc)" column, change "34.4524" to read: 40.4524; change "49.2466" to read: 57.2466; change "70.9048" to read: 80.9048.

Page 174. Par. 119c. Delete subparagraph *c* and substitute the following:

c. Spurious Response.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 117*c*. Rotate the BAND SELECTOR to band 1 and tune to 24 mc. Set the SELECTIVITY switch to 10 K.C. and R.F. GAIN-SQUELCH control fully clockwise.

(2) *Meter connections.* Connect Output Meter TS-585/U to terminals 1 and 2 of TB308. Set the input impedance to 600 ohms. Connect Signal Generator TS-497/URR to the receiver antenna input through adapter E101 and the dummy antenna. Adjust the signal generator for 2.5 uv at 24 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.*

(a) Tune the signal in on the receiver with the ANTENNA TRIMMER adjusted for maximum and the AUDIO GAIN 1 and AUDIO GAIN 2 controls adjusted for a 10 mw output with modulation, and a 1 mw noise output with modulation removed. The output as indicated on the output meter is a reference to be used in the remainder of this test.

(b) Lower the generator frequency 5 mc and increase the generator output 60 db. Continuously tune the signal generator until the frequency is 5 mc higher than the test frequency. At each spurious frequency indication, measure the ratio of the input level at the spurious frequency in relation to the reference level (10 mw).

(c) Repeat the above procedure at the following test frequencies; 34 mc, 48 mc, 68 mc, 96 mc, 136 mc, and 192 mc. Increase the signal generator output to 4.0 uv at 136 mc and 6.5 uv at 192 mc for a signal-plus-noise to noise ratio of 10 to 1.

(d) The rejection ratio of the spurious responses shall be at least 60 db.

Page 176. Par. 121a(2). Line 8. Change "2 uv" to read: 2.5 uv.

Page 177. Par. 121a(3). In the "Receiver input (uv)" column of the table, change the readings for bands 1 through 5 from "2.0" to 2.5, band 6 from "3.5" to 4.0, and band 7 from "6.0" to 6.5.

Page 177. Par. 121b(3). In the "Receiver input (uv)" column of the table, change the readings for band 6 from "6.5" to 7.5.

Page 178. Par. 121c(2). Line 8. Change "1 uv" to read: 1.2 uv.

Page 178. Par. 121c(3). In the "Receiver input" (uv)" column of the table, change the readings for bands 1 through 5 from "1.0" to 1.2, band 6 from "1.5" to 1.7, and band 7 from "2.0" to 2.2.

Page 179. Par. 122a(3). Line 7. Change ".1" to read: .33.
In the "Receiver input (uv)" column of the table, change the readings for bands 1 through 5 from "2" to 2.5; band 6 from "3.5" to 4.0; and band 7 from "6.0" to 6.5.

Page 180. Par. 122b(2). Line 3. Change "2 uv" to read: 2.5 uv.

Page 180. Par. 122b(3). Line 4. Change "5 volts" to read: 4 volts.
Line 5. Change "1.66 volts" to read: 1.33 volts. In the "Receiver input (uv)" column of the table, change the readings for bands 1 through 5 from "2" to 2.5; band 6 from "3.5" to 4.0; and band 7 from "6.0" to 6.5.

Page 193. Fig. 124. Change the value of C269 from 1,500 uuf to .1 UF.
Add the following note to figure 124:
6. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 15 AND HIGHER, RESISTOR R443 IS 560 OHMS.

Page 195. Fig. 125. Add the number "6" to the center terminal of the secondary winding (5-7) of transformer T601.
Insert figure 125.1 after figure 125.

Page 197. Fig. 126. Make the following changes in figure 126:

Change the value of R342 from 100K to 39K.

Change the value of R343 from 10K to 11K.

Change the value of R435 from 4,700 ohms to 3,300 ohms.

Add the following note to figure 126:
IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 15 AND HIGHER, RESISTOR R443 IS 560 OHMS.

Page 199. Fig. 127. Make the following changes in figure 127:

Change the value of R108 from 10K to 4,700 ohms.

Add the following note to figure 127:
4. ON BAND 1, RESISTOR R219, 330K, IS CONNECTED FROM THE JUNCTION OF R105 AND R107 TO GROUND. ON BAND 2, RESISTOR R220, 470K, IS CONNECTED FROM THE JUNCTION OF R105 AND R107 TO GROUND.

Page 210. Fig. 132. Delete figure 132 and insert new figure 132.

Page 211. Fig. 132. Delete figure 132 and insert new figure 132.

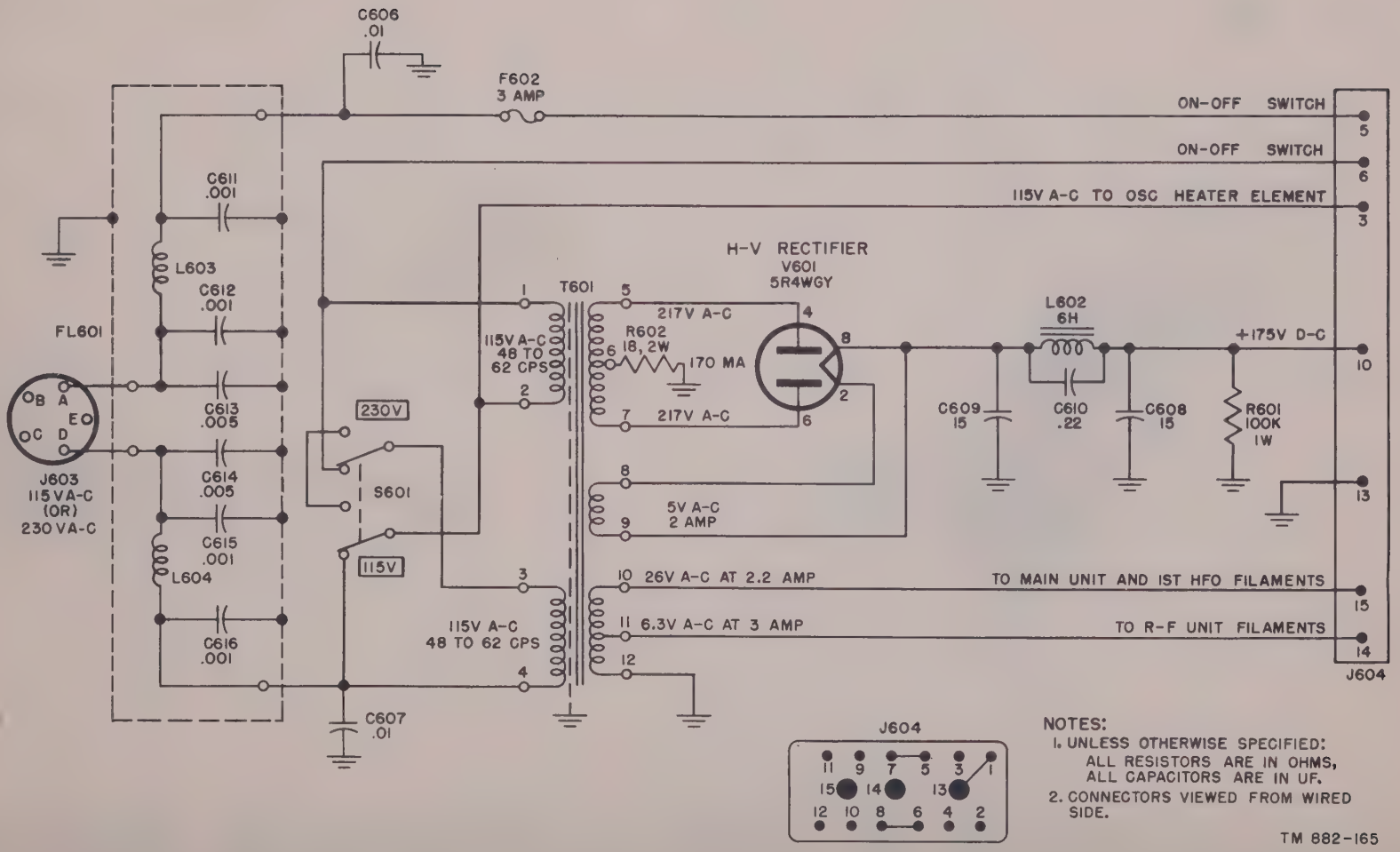
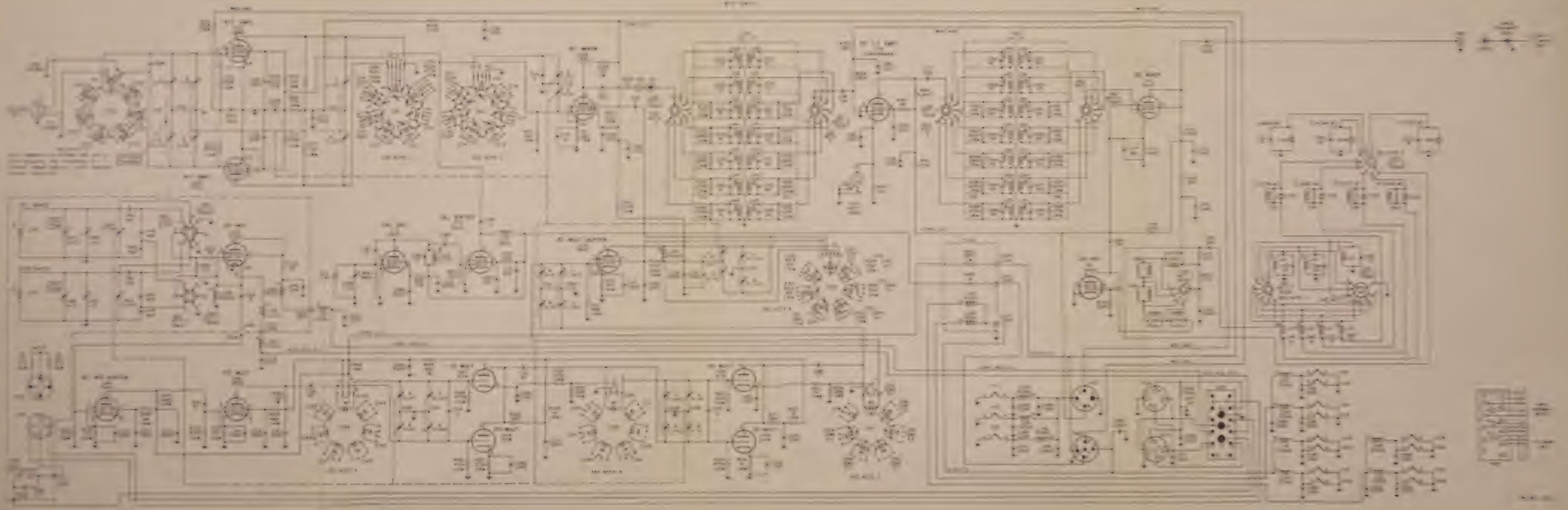
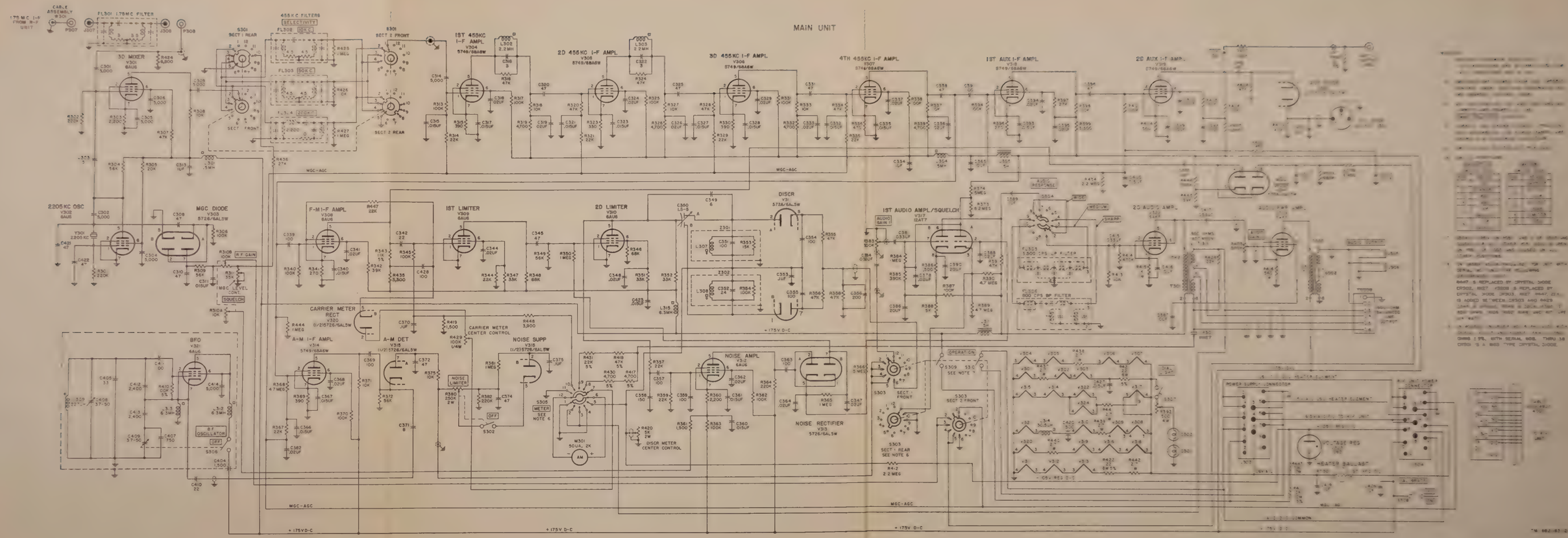


Figure 125.1. Power Supply PP-660/URR, schematic diagram (used on PP-660/URR units with serial numbers 2 and higher).




MAIN UNIT
CABLE ASSEMBLY W301
FL301 1.78MC FILTER
455KC FILTERS
S301 SECT 1 REAR
S301 SECT 2 FRONT
1ST 455KC I-F AMPL V304 5749/6BA8W
2D 455KC I-F AMPL V305 5749/6BA8W
3D 455KC I-F AMPL V306 5749/6BA8W
4TH 455KC I-F AMPL V307 5749/6BA8W
1ST AUX I-F AMPL V5-B 5749/6BA8W
2D AUX I-F AMPL V5-A 5749/6BA8W
3D MIXER V301 6AU8
2205KC OSC V302 6AU8
MGC DIODE V303 5726/6AL5W
F-M 1-F AMPL V306 6AU8
1ST LIMITER V309 6AU8
2D LIMITER V310 6AU8
DISCR V311 5726/6AL5W
1ST AUDIO AMPL/SQUELCH V317 12AT7
2D AUDIO AMPL
CARRIER METER RECT (1/2)5726/6AL5W
A-M 1-F AMPL V314 5749/6BA8W
A-M DET V315 (1/2)5726/6AL5W
NOISE SUPP V315 (1/2)5726/6AL5W
NOISE AMPL V313 6AU8
NOISE RECTIFIER V315 5726/6AL5W
BFO V321 6AU8
800 CPS BP FILTER
POWER SUPPLY-INVERTOR
MGC-AGC
+175V D-C

MOTOROLA

SINGLE UNIT

RAPID BATTERY CHARGERS

AEPD-23961-O

Single Unit Charger
NLN6897A

APPLICATION TABLE

CHARGER	NOMINAL CHARGE RATE	BATTERY
NLN6895A	250 ma - 1 HR RATE 25 ma - 10 HR RATE	NLN6899A
NLN6897A	450 ma - 1 HR RATE 45 ma - 10 HR RATE	NLN6900A

1. INTRODUCTION

These Single Unit Rapid Battery Chargers are optional items for the H23FFN, H24FFN, H33FFN, and H34FFN Series "Handie-Talkie" FM Radios, using the rapid charge nickel-cadmium battery power supply. They are approved under the manufacturer's guarantee covering the NLN6899A and NLN6900A Rapid Charge Nickel-Cadmium Battery Kits.

2. DESCRIPTION

a. General

These units are constant current type chargers which automatically provide two different charge rates. Initially, the battery is rapid charged at the one-hour rate, after which the charging rate is automatically reduced to a ten-hour rate. The battery can be left in the charger indefinitely without any resultant harm.

The charger can also be used to recharge "normal charge" nickel-cadmium batteries such as the Model NLN6682A and NLN6761A Battery, but only at the reduced ten-hour rate.

The chargers are basically identical except the Model NLN6897A is a heavy duty version for charging Model NLN6900A Heavy Duty Type Batteries.

The chargers operate from a 105-125 volt 50-60 Hertz source The power transformer has a tapped primary winding which is used to compensate for either high or low line voltage conditions.

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68P81[illegible]A87
Issue - A

[illegible]
[illegible] ng of your instruction manual. Use this information
[illegible] rect your manual.

[illegible] CTION MANUAL(S) AFFECTED:

[illegible] ngle and multiple unit Battery chargers

[illegible] ION DETAILS

[illegible] this change the following becomes effective:

[illegible]	Schematic Diagram No.	New Issue	Battery Charger	New Suffix	Change Item No.
[illegible]	63[illegible]119A90	A	NLN6848B	1	2
[illegible] 9A87-0	63C81119A88	A	NLN6695A NLN6897A	1 1	3, 4

(1) Component Changes

[illegible]	Ref. Sym.	Action	Part No.	Description
[illegible]	C6	Added	21K861478	CAPACITOR, fixed 0.22UF ±10%; 3V; SEE WIRING CHANGE
[illegible]	C1	Added	8D82905G12	CAPACITOR, fixed; 0.22UF ±10%; 50V SEE WIRING CHANGE
[illegible]	C[illegible]	Added		Same as change Item 1; SEE WIRING CHANGE
[illegible]	C[illegible]	Added		Same as change Item 2 SEE WIRING CHANGE

[illegible] iring Changes

[illegible] athode and gate of SCR1
of CR2 and CR3
[illegible] and gate of SCR1
[illegible] and CR1

b. Circuit Description

These rapid battery chargers are all solid state, automatic operating units for recharging NLN6899A and NLN6900A Nickel-Cadmium Batteries. Refer to the unit schematic diagram for the following circuit description.

When the battery is inserted in the charger receptacle, a current path is established from the battery thru the thermistor RT (part of battery) and transistor Q3. The thermistor initially has relatively low resistance (positive temperature coefficient) resulting in sufficient current flow thru R10 to cause transistor Q4 to saturate. Transistors Q4 and Q5 form a Schmitt-Trigger configuration resulting in the collector of Q5 going "high" (more positive logic level). This "high" is routed thru R8 to Q2, turning it on with resultant firing of SCR3 thru resistor R29. Resistor R29 and SCR3 provide the rapid charge mode of charger operation. In addition, the BATTERY CHARGING lamp is energized thru SCR1 and one side of the transformer secondary circuit whenever a battery is inserted for recharge.

As the battery approaches full charge, its temperature rises and consequently the resistance of RT also rises. This increase in resistance causes the voltage across R10 to drop, resulting in transistor Q4 turning off and Q5 turning on. The negative going pulse from Q5 drives Q6 to the off condition which fires SCR4. As SCR4 fires, a "high" is coupled to the base of transistor Q1 as well as to the gate of SCR2, thru resistors R24 and R25 respectively, causing SCR2 to conduct and light the RAPID CHARGE COMPLETE lamp. Conduction of Q1 turns off SCR3. When the annode potential drops to zero between dc line pulses), and therefore disables the rapid charge operational mode. When the RAPID CHARGE COMPLETE lamp illuminates, the BATTERY CHARGING lamp will go out since SCR1 is turned off (between dc pulses) due to the "low" voltage level at SCR2 annode (in conduction) being coupled thru CR5 to the gate of SCR1. This overall condition occurs when the battery is in a fully charged state and is being switched to the reduced 10-hour charge rate. This is accomplished by charging the battery thru resistor R28 with all fast charge circuitry in the off state.

In the event a "hot" (high temperature) battery is inserted into the charger for recharge, operation will be as follows:

The thermistor RT will have a higher than normal resistance value resulting in low current flow thru transistor Q3 and resistor R10. This low current prevents the Schmitt-Trigger (Q4 and Q5) from operating, and thus transistor Q2 and SCR3 are held at cut off resulting in low-charge rate operation. In this way a "hot" battery is protected from a rapid charge rate that could cause possible damage.

As the battery cools in the charger, Q3 starts to conduct more due to low thermistor resistance, thru R10, turning on Q4 and driving Q5 into cut-off. As the collector potential of Q5 goes "high", transistor Q2 saturates and fires SCR3 to initiate the rapid charge cycle of operation as explained previously.

3. OPERATION

Place the battery charger in operation as follows:

a. Connect the ac line cord to a 105-125 volt, 50-60 Hertz source.

b. Insert the bottom end of the radio set with the speaker to the front, or the battery only, into the charger receptacle. Make sure that the battery or radio is firmly seated. The BATTERY CHARGING lamp (red) will light indicating that the battery is being charged.

NOTE

Only radios with four-contact front covers will have the battery rapid charged while in the radio housing. Radios equipped with three-contact front covers will have the battery slow charged only. In any case, the battery can be rapid charged when removed from the radio set.

After the battery is fully charged the RAPID CHARGE COMPLETE lamp (green) will glow, the BATTERY CHARGING lamp will extinguish. At this time, the charger is operating at the reduced 10-hour charge rate.

NOTE

Make sure that the lamps are glowing, otherwise the battery is not being charged.

WARNING

Do not discard old batteries in fire as they may explode.

4. MAINTENANCE

a. Fuse

If the charger does not operate, check the line fuse in the primary circuit of the charger. If the replacement fuse also "blows", check for short circuits in the transformer and charger circuitry. A short circuit across the contact pins of the charger receptacle will not cause the fuse to "blow".

b. Line Voltage Compensation Adjustment

Check the value of the ac line voltage supplied to the charger. If the line voltage is above 125 volts, remove power from charger. Remove the line cord lead from the grn-blk transformer lead on the terminal board and connect it to the red-blk transformer lead.

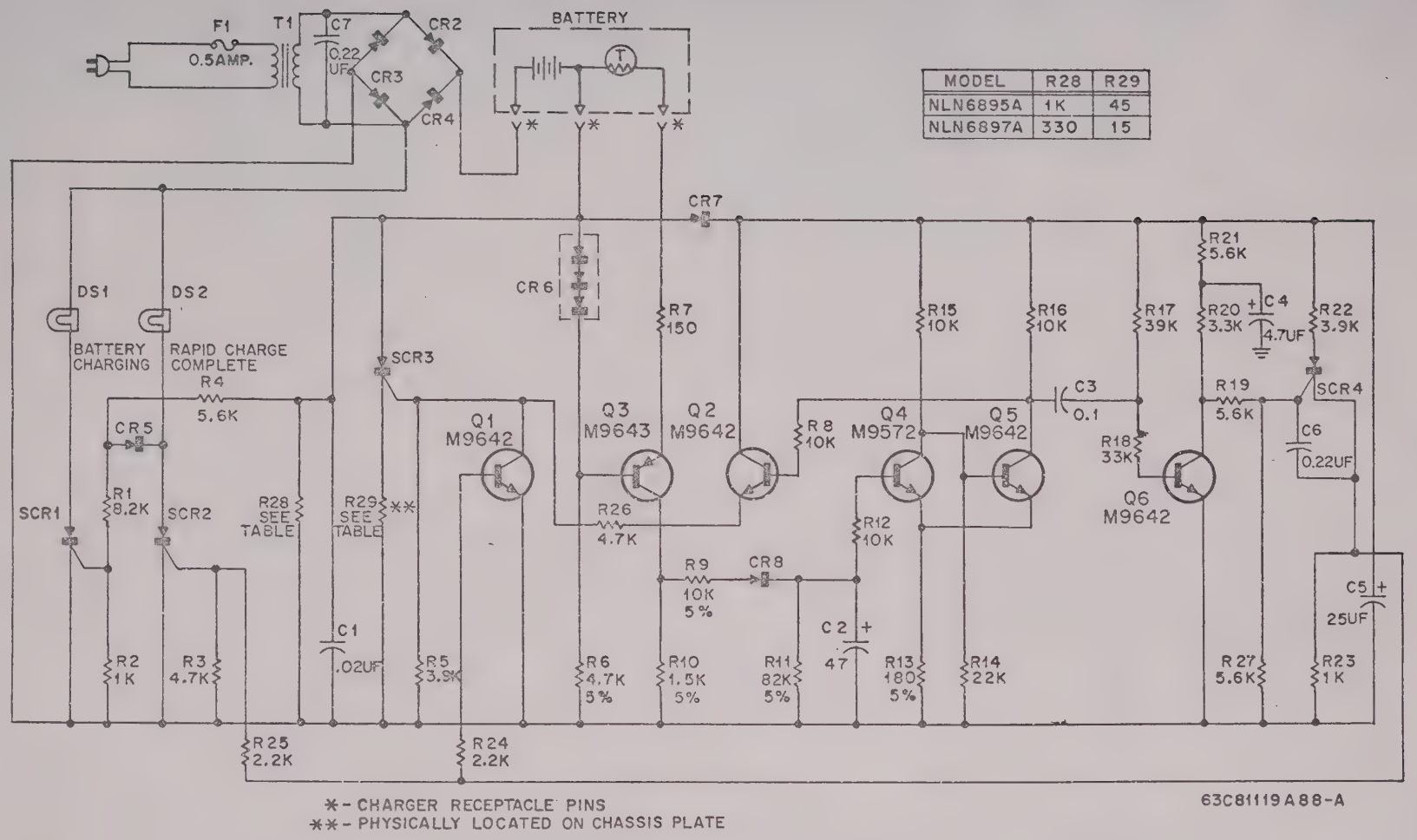
If line voltage is below 105 volts, remove line cord lead from grn-blk lead on terminal board and connect it to the yel-blk transformer lead.

c. Contact Pins

If the BATTERY CHARGING lamp does not light when the radio is inserted, check contact pins of radio and charger for dirt and grease or other foreign matter.

NOTE

The radio set incorporates an internal safety feature to prevent charging mercury-type batteries. Therefore the BATTERY CHARGING lamp will not glow when a mercury battery equipped radio set is placed in the charger receptacle.



MODEL	R28	R29
NLN6895A	1K	45
NLN6897A	330	15

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
A	NLN6895A-1 NLN6897A-1	C7	ADDED 0.22 UF	C6	EPD-23755-A
				SCR4 CATHODE	
			ADDED 0.22 UF	T1	

PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

Charger Schematic Diagram
Motorola No. 63C81119A 88-A
4/7/70-UP

PARTS LIST

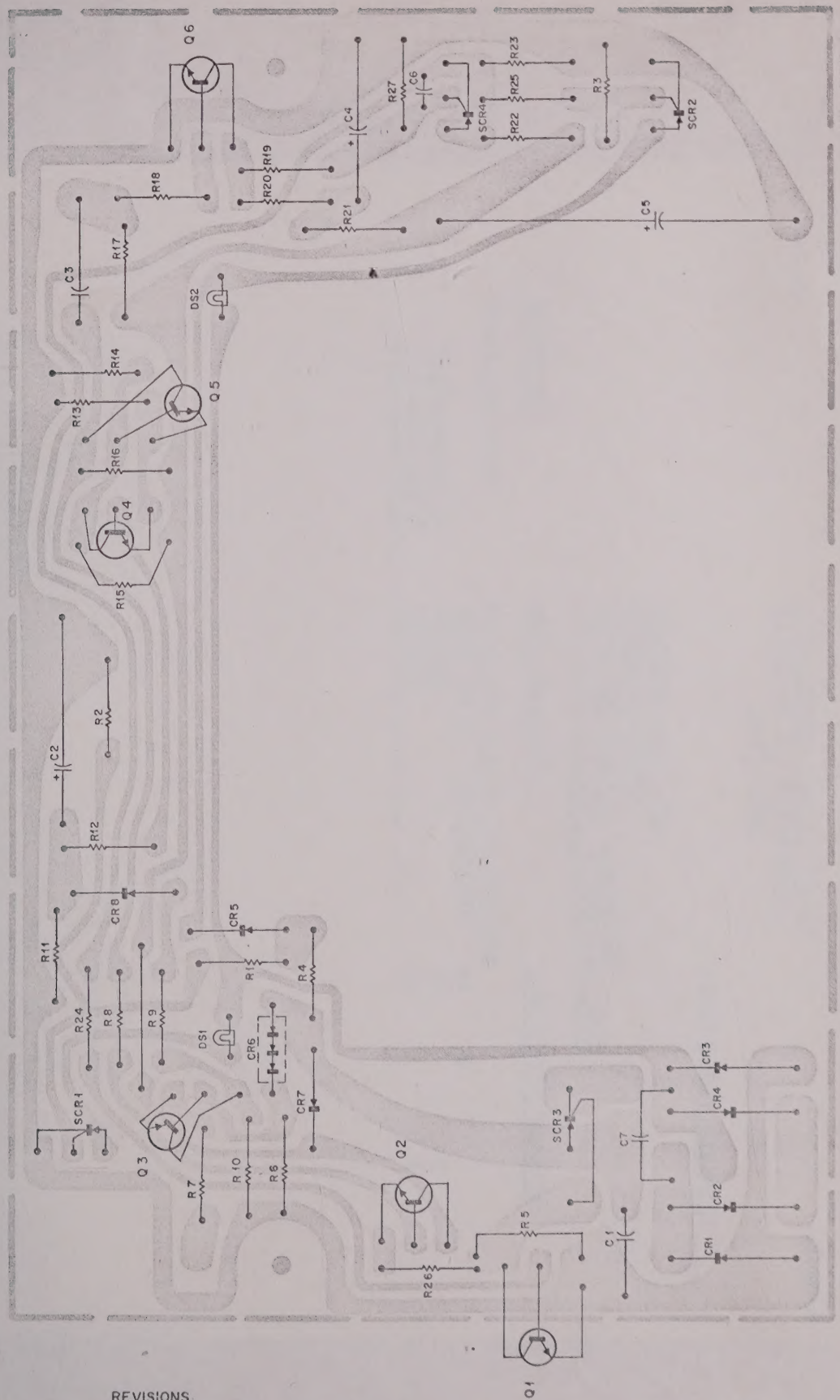
NLN6695A Rapid Charger Single Unit
NLN6697A Rapid Charger Single Unit EPD-23887-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf; unless stated
C1	21D42426B26	.02 +80-20%; 200 v
C2	23D8447n2H02	47 ±10%; 6 v
C3	8D82905G07	0.10 ±10%; 50 v
C4	23D84762H04	4.7 ±10%;
C5	23D82601A08	25 +150-10%; 60 v
C6	21K861476	0.22 ±10%; 3 v
C7	8D82905G12	0.22 ±10%; 50 v
		SEMICONDUCTOR DEVICE, diode; SEE NOTE
CR1, 2, 3, 4	48C82466H03	silicon
CR5, 7, 8	48C82392B03	silicon
CR6	48C83329G04	silicon
		LAMP, incandescent
DS1, 2	6SC84686H01	14 volts
		FUSE, cartridge;
F1	6SK475395	.5 amp; 125 v
		CONNECTOR, plug:
P1		part of W1
		TRANSISTOR:
Q1, 4, 5, 6	[illegible]	N-P-N; type M9642
Q2	[illegible]	P-N-P; type M9643
Q3	[illegible]	N-P-N; type M9572
		RESISTOR, fixen: ±10%; 1/4 w: unless stated
R1	[illegible]	8.2K
R2, 20	[illegible]	1K
R3, 26	[illegible]	4.7K
R4, 19, 21, 27	[illegible]	5.6K
R5, 22	[illegible]	3.9K
R6	[illegible]	4.7K ±5%
R7	[illegible]	150
R8, 12, 15, 16	[illegible]	10K
R9	[illegible]	10K ±5%
R10	[illegible]	1.5K ±5%
R11	[illegible]	82K ±5%
R13	[illegible]	180 ±5%
R14	[illegible]	22K
R17	[illegible]	39K
R18	[illegible]	33K
R23	[illegible]	3.3K
R24, 25	[illegible]	2.2K
R28	[illegible]	1K; 1/2 w; (NLN6695A only)
	or6S6254	330; 1 w; (NLN6697A only)
R29	17C82361A20	45; 20 w; (NLN6695A only)
	or17C82361A19	15; 20 w; (NLN6697A only)
		RECTIFIER, controlled
SCR1, 2, 3	48D84765H01	silicon; type 2N5061
SCR4	[illegible]	silicon, type MCR406-2
		TRANSFORMER, power
T1	[illegible]	Pri: #1 RED-BLK; 125 v ac #2 GRN-BLK; 115 v ac #3 YEL-BLK; 105 v ac #4 BLK; common 22.5 ohms between term 1 and 4 Sec: #5 BRN #6 BRN-YEL 1.5 ohms between term 5 and 6
W1	[illegible]	CABLE, assembly, power: 2 conductor; rubber covered: #16 str inclines 2 contact male [illegible]
XF1	[illegible]	[illegible]

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	NON-REFERENCED ITEMS	
	42B8201A05	RETAINER, cable
	15D8222 1B03	BASE, charger
	7015016B01	BUTTON, 4 req'd.
	11A82093A02	SPRING, compression; 4 req'd.
	11A8357/1B01	SPRING, contact, 4 req'd.

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.



REVISIONS

DIAG. ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	NLN6895A-1	C6	ADDED 0.22 UF	SCR 4
	NLN6897A-1	C7	ADDED 0.22 UF	BOTTOM LEFT

Printed Circuit Board Diagram
Motorola No. PEPD-23755-A
4/7/70-UP

5960-537-3961	TUBE, 5718	EA	4	2
5995-280-3298	CABLE ASSEMBLY	EA	1	
5995-284-5955	CABLE ASSEMBLY	EA	1	
5995-284-5958	CABLE ASSEMBLY	EA	1	
5995-549-5863	CABLE ASSEMBLY	EA	1	
6240-155-8706	LAMP, INCANDESCENT	EA	2	1
*TM 11-882	TECH MANUAL	EA	2	
*NSNR	INSTRUCTION BOOK	EA	2	

*NOTE: ASTERISK INDICATES 2 EACH TM 11-882 WAIVED PER CHIEF OF INSPECTION OFFICE, SSD. INSTRUCTION BOOKS SEND IN LIEU OF TECH MANUALS.

BD # 841

1 EA. POWER SUPPLY, PP-660/URR, S/N 5820-500-4444 IS INSTALLED IN RECEIVER, R-220/URR.

SACRAMENTO SIGNAL DEPOT
SACRAMENTO, CALIFORNIA
MAY, 1958

ASSEMBLER: BUMPASS

PACKING LIST FOR
5820-503-1260
RECEIVER RADIO, R-220/URR
IPL DTD: 15 AUG. 57 (204180-220)

STOCK NO	NOMENCLATURE	U/M	REQ'D	SPARES
5820-503-1260	RECEIVER RADIO, R-220/URR			
	BARE UNIT, F/R-220/URR	EA	1	
5120-293-1516	WRENCH	EA		1
5120-293-2270	WRENCH	EA		1
5120-333-9812	TOOL, ALIGNMENT	EA	1	
5306-521-0564	BOLT, MACHINE	EA		8
5310-523-2147	WASHER, FINISHING	EA		8
5905-258-0795	RESISTOR, THERMAL	EA	1	2
5920-010-6652	FUSE, CARTRIDGE	EA	1	5
5935-201-2410	CONNECTOR, ADAPTER, UG-971/U	EA	1	
5955-242-9850	CRYSTAL UNIT, CR-18/U	EA	1	1
5955-295-7431	CRYSTAL UNIT, CR-18/U	EA	1	1
5955-295-7435	CRYSTAL UNIT, CR-23/U	EA	1	1
5955-295-7436	CRYSTAL UNIT, CR-18/U	EA	1	1
5955-295-7452	CRYSTAL UNIT, CR-23/U	EA	1	1
5955-545-7346	CRYSTAL UNIT, CR-18/U	EA	1	1
5955-667-2403	CRYSTAL UNIT, CR-18/U	EA	1	1
5955-667-2424	CRYSTAL UNIT, CR-23/U	EA	1	1
5955-667-3270	CRYSTAL UNIT, CR-23/U	EA	1	1
5960-030-0242	SHIELD	EA	11	
5960-166-7648	TUBE, 0B2	EA	1	1
5960-166-7662	TUBE, 12AT7	EA	1	1
5960-166-7676	TUBE, 6AU6	EA	11	4
5960-188-3551	TUBE, 6AK6	EA	2	1
5960-193-5111	TUBE, 5R4WGY	EA	1	1
5960-230-5241	TUBE, 5840	EA	7	2
5960-262-0015	SHIELD	EA	6	
5960-262-0185	TUBE, 5726/6AL5W	EA	6	2
5960-264-2089	TUBE, 5749/6BA6W	EA	8	3
5960-264-3004	SHIELD	EA	1	
5960-265-0573	SHIELD	EA	1	
5960-272-9094	SHIELD	EA	20	

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